See also

Laguna Hills site

Loc 1945 † Laguna Niguel also

for shearwaters

from that locality

† comparisons

with others

7.15
75
75
70
74
72
74
72
75
73
72
5

11)80.55 (7.3
77
35

80.55
765
12)88 20 (735
84
42
36
60

6.2
6.4
6.4
6.1
6.35
6.35
6.5
6.2
6.9
6.7
5.9
6.4

12)76.36 (6.3
72
46
36
100

6.6
6.9
6.9
6.75
7.0
6.6
6.9
6.6
6.9
6.7
6.9

11)74.75 (6.79
66
87
77
105

4.9
5.2
5.0
4.9
4.7
4.7
4.6
5.0
4.9
5.1
4.6

11)53.57 (4.8
44
97
88
9

83
76)6308
608
220
depth 8 ft 5 in
or dust
breakoff 54
76)7600
568
320

50.70
62)3100
310

55.9
59)3300
295
350
295
550

56.9
58)3300
290
400
348
520

formed

51
62)3200
310
100
50

quotient 58.5
58)3400
290
500
464
360

61)3100
305
50

87
81)7100
648
620

82)

Peromyscus

	El Toro	P. ajustus	P. gris. mus	P. felt. type	P. boyaldi mm	P. diat.	P. gym. mitchelli
Br. humerus	7,1 (2) 7,5 (1)	7,0 – 7,65 7,35 av.	8,9	8,6	7,3 – 8,1	7,1	7,3 – 7,5
				cotype 7,3	type 6,45	6,8	— —
Br tarsus	6,6, – 7,0, 7,2 7,5 – (?)	5,9 – 6,9 6,38 av.	8,0				
Depth ext sh. tarsus	4,2 – 4,5 5,1	3,3 – 3,9	4,4	4,2	3,9	4,7	— —
Br. proxulna	6,3, 6,6(2) [6,9]	6,6 – 7,0 6,79 av.	8,3	—	—	—	— —
gr. dist Br. ulna (diag.)	7,2 – 8,1	7,1 – 7,4	9,0	—	—	—	— —
depth dist ulna	5,1 – 6,0	5,5 – 6,1	7,4	—			— —
Br coracoid	prox. dist. across 4,9, 5,4 (2), (5,7)	4,6 – 5,0	5,8				
proxulna to head	11,7 & 12,4	10,8 – 12,3	14,0				

Measurements of referred specimens of Pappus calhoni

		17539	17540
Humerus 17508			
Br. dist. end	7.1	7.1	—
Dist. Atp. ectepi	9.5	9.2?	—
depth ext	6.5	8.0	—
" int	8.0	6.6	—
Br. sh. ulnar ectepi zone	3.2	3.4	3.3
depth " "	6.2	6.0	6.0
Ulna 17530			
Br. prox	6.6		
Depth prox	7.7		

							Femur 17538
Tarsus 17582		17537	17524	17524	17536	17527	7.0
Br prox	6.6 apx (inc.)	7.1	—	—	—	—	—
Depth sh ext	4.4	4.3	4.4	4.1	4.3	4.4	4.5
Br sh ectepi	3.0	2.8	2.8	2.6	2.9	2.8	3.5
Depth prox	5.9	6.1	—	—	—	—	
Length calc ridge	6.8	6.6					6.5?
" ext " "	3.9	3.3					3.8?
Br. hypo at base	3.5	3.9					4.3?

Keep

Puffinus calhouni, new species

Type: Distal end of right humerus (LACM 17508), collected by W. Earl Calhoun, Jan. 18, 1965.

Locality and Age: Lacm locality 1945, Leisure World, Laguna Hills, Orange County, California; 1¼ miles southwest of the town of El Toro, ¼ mile north of Aliao Creek in the SW/4 of NE/4 of SW/4 Sec. 34, T 6 S, R 8 W, Orange County, California: San Juan Capistrano quadrangle. Late Miocene ?

Diagnosis: Humerus near the minimum in size range of humeri of P. opisthomelas; impression of brachialis anticus muscle deep, moreround than oval, and not extending proximally beyond upper level of ectepicondylar process; surface of attachment of articular ligament shorter and broader than in P. opisthomelas, slightly convex and facing more palmad than laterad; external condyle narrow.

Referred specimens: Distal end of left humerus, LACM 17539; proximal end of right ulna, LACM 17530; proximal 2/3 of left tarsometatarsus, LACM 17582, found at the same time as the type; ~~and~~ proximal end of right tarsometatarsus, LACM 17537. An incomplete distal end of humerus, LACM 17540, an incomplete proximal fragment of tarsometatarsus, LACM 17536, and three fragments of tarsometatarsal shafts, LACM , with portion of hypotarsus present, are tentatively assigned.

The ulna is near the minimum in size range of P. opisthomelas; the attachment of the anterior ligament is narrow and straight and terminates distally well below the level of the lip of the external cotyla; the ridge connecting the lip of the external cotyla to the shaft does not terminate in a distinct papilla. The tarsometatarsus 17582 is heavier than that of P. opisthomelas; the internal calcaneal ridge is slightly mediad of the internal surface of the shaft, and the shaft

Pupfauna — El Toro

Humeri

Type calhouni – humerus 17508

Ref. " " " 17539

Ref P. prisca " 17548 (ulna a type from Shackbottle Hill ref # 17502, unrec'd

Unassigned dist sh " 17542

" prox sh " 17541

" dist pig worn " 17540

" 2 prox " 17521, 17522

Ref bent, prox ulna 17530 very long narrow articulg. attach calhouni

unassigned (3) " " 17532, 44, 35 slightly larger shafts badly; But not prisca because not indented & olecranon on ~~sht~~ side

Ref prisca prox " sh 17547 — resemble prox ulna of Shackbottle Hill 17503 was larger ~~as~~ 17505 mitchelli?

One humeral shaft, 17542, in which the distal end is partially preserved, has an even more convex surface for the ant. art. lig. than in P. calhouni, with the small depression at the lateral edge that doesn't appear in specimens here assigned to P. calhouni, but is present in types of P. prisca & P. mitchelli. The shaft is more slender than in the latter species, however.

On prox. ulna 17532 the papilla below the lip of the ext. coryle is more prominent than in the ulna ref'd to P. calhouni (17530) but less so than in ulna 17503 from Shackbottle Hill assigned to P. prisca or ulna 17547 from the present site so assigned. The surface for the ant. art. lig. is more obliquely placed & more kidney-shaped than in 17530 but relatively longer than in the Shackbottle Hill specimen. Other portions of humeri (1 shaft, 2 prox.) and ulnae (2 prox, 3 dist.) do not show diagnostic characters

The three small Lasiorhinalara have only shaft or distal portions preserved.

Elton
Fulman D. nig. Elton — more like Fulman in proportions & conformation

11,1 18,7 13,1 carpus thin M1

7.068% 11,4 60% 8,9 68% " but M1

Sketchbook — Dromedea

8.7 17.3 14.3 ulna br prox

8.6 98 14.6 84.5 90 12,5 87,5 % " deltoid ridge & ulna olecranon

Re - Shamrocks 3.24.65

	a Br. fr.	b Br. fr.	c Br. dist.	d Ht to top ectoplasm	e br. sh	f depth sh	g sh mid br x depth	h sh mid br x depth	i ratio	yl cd
P. carina	left	med to ant tube	conduct							
49	106.7	17.7	9.0	12.0	3.7	7.0	3.7	6.85	54.5	52.7
50	104.3	17.4	9.0	11.5	4.15	7.65	4.15	7.2	57.5	54.3
64	106.8	16.8	8.9	11.6	3.9	7.3	3.8	7.2	52.8	53.4
60	106.8	17.7	8.8	11.7	3.75	7.1	3.9	7.2	54.2	52.7
299	108.5	18.0?	9.1	12.5	3.9	7.6	4.1	7.3	56.2	51.3
577	101.6	17.2	8.7	11.9	3.7	7.2	3.8	7.1	53.5	51.4
P. crassa	698	17.1	8.8	11.7	4.55	6.8	4.5	5.9	76.3	66.9
	349	17.0	8.8	11.5	4.2	7.1	4.5	5.7	78.8	59.2
	348	16.8	8.9	11.3	4.1	6.3	4.4	5.8	75.8	65.2
	662	17.5	8.8	11.7	4.2	6.8	4.6	5.8	79.3	64.4
P. spirit										
	554 84.5	14.0	7.8	9.9	3.3	5.95	3.4	5.6		55.4
	549 84.9	14.4	7.6	9.9	3.1	6.1	3.3	5.9		50.9
	542 84.3	13.8	7.7	9.8	3.4	5.5				
	556 77.2	13.0	7.3	9.2	3.0	5.25	3.3	5.0		

sh 90

3.25 6.2 51.4

Eltrov lostw								50.0	64.5	76.4
	7.1	9.3	3.0	6.0						
	7.1	9.2?	3.35	5.9				56.7	64.2	77.3
	—	?	3.3	5.8				56.7	—	—
	shape with width	→	3.15	6.1	3.3	5.8	56.9	51.3	—	—
P. feltham	8.9	10.99	3.5	6.9	3.35	5.9	56.5	50.6	63.0	81.1
P. kanahofi 2160	9.45	9.7	3.25	6.15	3.4	5.8	58.4	52.8	63.3	76.9
2120	7.2	9.0	3.0	5.5	3.4	5.4	63.0	54.8	61.0	79.7
2514 84.4	14.7	—	—	3.4	6.3	3.6	5.5	65.5	54.0	—	—
P. mutchelli		8.5	11.0	3.85	6.95				55.4	63.1	86.6
P. primus		7.6	10.0	3.25	6.2				52.5	62.0	76.2
P. incaptus		9.1	10.1	3.65	5.95				61.4	58.9	91.0
P. dichromus 79.45	—	7.6	11.65	—	6.9				—	59.2	65.3
P. conradi	—	—	9.2	11.9	4.95	7.7			64.3	64.6	77.3

main dif. bet. P. grisens & P. creatops

P. gris. shorter, with deeper but thinner shaft

" " at distal end sh more diagonal so that when that dimension obtd the distal end is measured, bone faces nearly palmad, whereas to get min diner. in P. creatopus the side of the bone faces. The measurer. of P. creat could be exactly measd with distal end facing palmad It would be about .5 mm greater than min.

1877 P. gravis is very like creatops but a little longer

1379, 3585 P. pacificus is a smaller version of P. creatopus in the characters above noted

3544 3549 P. gris Nomelas is like P. grisens in these characters

935 P. obscurus (much smaller) is between P. creat. & gris. in these chars

1731 P. tenuirona has a more rounded shaft distally than creatopus but mid part of dr. is like creatopus.

Shape of Impression Caudad: 1 Round & deep: gravis, pacificus, conradi* (very deep)
2 Narrow & deep: P. opisth., diabolicus*
3 Between 1 & 2 thick: P. grisens, P. priscus* P. mitchelli*, El Toro*
4 Narrow & shallow: P. kanahoffi*
5 smaller: P. incertus

Fossils

P. kanahoffi very like P. opisth. (same in size.) but bacual impression shallow

P. diabolicus also about same size but ectepi proc. higher

El Toro also about same size, ectepi proc. as in kanahoffi, but bacual impression rounder & deeper & shaft slightly more compressed. El Toro is close to P. priscus from Shenkstoth Hill — possibly more slender but different as say

Misc:
Statum B Aug 1964
Complete small ulna
frag sh - small humerus
Statum A Aug 1964
Dist sh, humerus (small)

17 Small Acid
6 Tiny
1 dist frag humerus 8.15.64
1 " " " 8.20.64 stat A
1 frag coracoid 8.15.64
1 dist frag carpometa 8.15.64
2 frag coracoid Dec 1964

4 Medium A
1 complete ulna short & deep Dec 1964
1 distal end " " " " " "
1 prox carpometa ——— " "
Size? ? 1 coracoids
A or B
4 Medium B
1 prox ulna Dec 1964
Size? ? 2 coracoids Dec 1964
A or B ? 1 scap
3 Medium C
1 prox half ulna Dec 1964
1 mc. dist carpometacarpus no data (1964?)
1 shaft & part dist end humerus no data (1964?)

Puffinus from El Toro (= Laguna Hills)

59 Puffinus
2 fulmarus

4.12.65

Tarsus
2 prox Dec 1964
2 nic prox " "
2 dist " "
2 prox part shaft Dec 1964
1 dist part " " "
1 " " " (1.18.65)
1 " " " (8.20.64 strat A)
1 prox 1/2 1.18.65
1 dist 3/4 1.18.65
1 prox frag 1.18.65

Ulna
7 distal (Dec. 1964)
2 prox " "
1 " shaft " "
1 dist ulna (aug 1964 strat B)
1 " " no data
1 prox " " "

Carpometa
1 prox (Dec 1964)
1 dist " "

✓ 1 prox end fulmarus large NO DATA

Humerus
2 distal (Dec. 1964)
1 prox tip " "
1 " shaft " "
1 distal " " "
1 frag. shaft " "
1 shaft (aug 1964 (strat. A)
1 upper shaft (1.22.65 Cashown)
1 dist end 1.18.65

Tibia
1 distal (Dec 1964
1 " aug 1964, strat. B)

Scapula
1 Scap 1.18.65
2 Scap Dec. 1964

1 distal frag. = fulmarus (large) NO DATA

Coracoid
4 upper part (Dec. 1964)

Radius
2 prox (Dec 1964)
2 dist (" ")
1 dist (1964)

Phalanges
1 Tmic
1 Cmetajom (Dec 1964
1 quadrate " "
2 wing phal. 2/1 " "
1 dist femur " "
2 prox Scaps " "

= P. priscus
Shaulov Hill unrec'd

Humerus < Pudimus
Shaulov Hill + El Toro

P. Mitchelli 558

El Toro

	P. priscus	P. pusius	P. mitchelli	P. Mitchelli 558	P. incepta	El Toro (2)	El Toro (1)	El Toro Julmar	El Toro (3)
P. dist tyhd									
dep. dist ext condyles	7.0	6.7	7.65	6.2	7.3	6.1	6.35 —	8.24	— 7.0
diag. length ext. condyle	6.2	6.2	6.6? Boxer	5.9	7.0	6.0	6.1	5.37	— — 6.0
distance distal end to top of ectepicond. prominence	10.3	9.8	10.9	9.5	10.4	9.4	9.2 —	12.9	— 9.0
dist. end to mid. dectepicond prominence	8.5	8.0	8.7	7.5	8.5	7.5	7.6 —	11.0	— —
7.2 br across condyles	7.6	7.5	8.7	7.3	9.2	7.3	7.6 —	—	— 7.9
7.6 depth ant cond.	9.1 —	8+?	—	8.6	9.3	8.0	8.1 —	—	— 8.7
ht to br brachial impress.	4.6 x 3.0 65.9%	4.4 x 3.1 70.5% 76.6%	5.4 x 3.6 66.6%	4.5 x 2.8	5.0 x 3.4	3.9 x 3.1 79.5%	4.2 x 2.7 64.4	3.8 x 2.5 65.7 —	4.1 x 2.4 58.5 —
length ant. lig. attach	—	3.0 x 2.3	3.5 x 2.4	3.8 x 1.7	3.5 x 2.1 broken	3.65 x 2.2 61.96	3.6 x 2 55.6 —	—	4.3 x 2.3 52.4
6.3 br sh unmed. aber 6.2 br sh. - ligament attach	—	6.0 x 3.75 6.2 x 3.2	7.7 x 4.2 6.7 x 3.9	6.0 x 3.4 5.1 x 3.3	6.8 x 4.5 5.9 x 3.7	6.5 x 3.25 5.8 x 2.9	6.3 x 3.4 6.2 x 3.3 —	6.2 x 3.2 shaft measure	— 6.0 x 3.1

"EQtaO"

LACM Loc 1945 Rancho La Brea

Tarsometatarsus (12) add'l

2 prox ends R — 17538 (prox?), 17537 (prox?) X

1 " frag L — 17536 P. calhouni? X

~~1 mid frag L~~

~~1 frag sh (prox) L~~

1 dist end R — 17523 P. sp X

1 " frag L — 17518 P. sp X

1 frag sh (dist) L — 17524 P. sp X

1 haf sh (dist.) L — 1965 17543 P. sp. X

1 sh (mid) R — 17524 X P. cal? To be remarked

2 " (mid L — 17524 (2) X

P. calhouni 1 prox ½ mic L — 1965 17582 X

P. sp. by 1 " end mic L — 1965 Laiyu 17549 X

Ulna (13) add'l orec

P. pussis? 1 prox half mic L 17547 X

calhoni 1 " right R 17530 X

sp 2 prox end R 17532 X 17544 P. sp? X

2 " " L 17535 P. calhouni X sp?

2 dist " R 17534, 17533 calhouni?

" " R + shaft numbers

3 " " L 17525, 17527 X calhouni?, 17519 P. sp X

~~1 dist " mic. L small numbers~~

1 mic (dist half) R 17513 P. sp X

Humerus (8) add'l orec

1 shaft + part prox 17541 P. sp. X

Type calhoni 1 dist end R 17508 X

P. pussus? 1 " " R 17548 X

ref. calhoni 1 " " L 17539 X

1 " " mic R ~~shaft~~ 17540 X weathered dark ident?

1 " " haf mic L 17542 P. sp X

1 prox tip R 17522 P. sp X

1 prox (Belowhead) L 17521 P. sp X

Coracoid (4)

3 pp ends R P. cal? 17528 X, P. cal 17529 X, P. cal.? 17539 X ident?

1 " " L 17531 P. sp X

Tibiotarsus (2) add'l orec

1 dist end (mic) + R (large trochlea) 17517 P. sp. X

~~1 " " " R small numbers~~

Scapula (3)

2 art ends R 17520, 17512 X P. sp.

1 " " L (gray 17545 P. sp X

Femur (1)

1 dist R 17514 P. sp X

Wing phalanges

2 " " 17511 X, 17511 X P. sp. X

Cuneiform

1 " 17509 P. sp X

Quadrate

1 " 17510 P. sp X

Tarsus 12
Ulna 13
Humus 8
coracoid 4
tibia 2
Scapr 3 ~~P. sp?~~
Radius 4
Carpo. 3
Femur 1
Phal. 2
Cun. 1
Quad 1

54

Radius (4) Pupinus

1 dist end 17515 P. sp X

1 dist mid numbers X

2 prox end " XX

Carpometacarpus (3)

1 dist R numbers X

1 prox L " XX

1 int R 17546 P. sp X

Unnumbered Pappus not listed on

X Dist sh L tarsus

X gh (ons) L humus

X sh dist R tibia

X dist ulna

"El Toro" 4.15.46
Puffinus
LACM Loc 1945

Coracoid

	R	R	R frag	L frag	♀ 55 ♂ ortho
under scap facet & head	12.4	11.5	—		11.3
br. fossa below head	5.4	5.4	5.3	5.7	4.7
br head	5.75	5.8	5.5	5.4	5.6

Chars. ① strong longit. depression through fossa as in gisenis
② also neaer gisenis than ortho., in lack of deep depression immed below clavicular facet and (anti'ly) more rounded, less depressed, thruout,
can't see diatomeus
③ also unlike ortho & like gisenis, ↑ pack. & quadrans in straight clavicular facet, not flkd.

Scapula

Br prox	10.0	—	9.7	—
Br sh	3.4	3.9	3.7	3.2

Chars. ♂ rather heavier & with more distinct acromion & coracidal tub. than ortho. or gisenis

Radius

		♂ ortho
Br dist	5.9	5.7
Depth "	3.7	3.8

ANNOTATED LIST OF SPECIES

Order Procellariiformes

Nearly half the bone fragments in the collection from locality 1945 can be assigned to this order. These represent two families, and three genera, and probably five to six species.

Family Diomedeidae, Albatrosses 2

Diomedea, sp.

A small fragment of the shaft of a tarsometatarsus near the proximal end (LACM no. 17550) can be referred to the genus Diomedea, but a species assignment is not practical. In size the tarsometatarsus is similar to this element of D. nigripes, and is, therefore, too small to be assigned to D. californica from the middle Miocene of Sharktooth Hills, California, and too large for D. milleri from that same locality. A Pedal phalanx of a much larger, a second sp. Diomedea albatrus

Family Procellariidae, Shearwaters, Fulmars 66 2

Genus Puffinus, Shearwaters (3 sp.)

Forty-six fragments represent the genus Puffinus. Of the previously described seven species of North American fossil shearwaters, the humerus and tarsometatarsus are the most diagnostic elements. In the Laguna Hills material, there are three fragments of humeri and five of tarsometatarsi in which details of structure are sufficiently well preserved for at least tentative specific assignment. Two of the humeri and four of the tarsometatarsi are believed to represent an heretofore unknown form, here described. The other humerus and tarsometatarsus possibly represent two other species.

P. calhouni

lt tars - grasp well mineralized
type humerus 17508
ref " 17339 more mottled
" ulna prox 17530
" prox end tars 17582

lt tars + more mottled
tapsus dist 3/4 17543
scapa 17545

18 total Coelo

same preservation sp?
1 wing phal. uc. 17517
cuneiform 17509
quadrate 17510
" dist ulna? 17533 (may be brown)

brown smooth - 35
4 coracoids (all)
humerus P. pustus? 17548
ulna shaft P. pustus? 17547
1 wing phal, 17511
tarsus wing prox 17549
2 scapulae 17520
17512

ulna dist 1/2 no # 17526
3 dist ulna 17527
17525

2 prox ulnae 17544
17530

1 sh tarsus 17528
3 prox " 17538
17537
17536

2 dist " 17518 lt + rt tars
17523

1 dist femur 17514
1 " tib 17517
1 " " no #
1 " prox ulna no # (lt side)
1 " frag humerus 17540 water worn
2 sh humeri 17542 (dist)
17541 (prox)

3 sh tarsus 17524
1 prox frag 17521
1 dist rad 17515

1 prox frag humerus 17522
1 " carpus no #
1 dist " no #
2 prox rad no # (1 lt in color)
1 dist " no # " " "

1 " carpus 17546
2 " ulna 17513
17519

35
18
53

53

Puffinus ?priscus

Three well preserved distal ends of humeri are close in size to living Puffinus griseus Pomelas as is true, as well, of three North American fossil species: P. diatomicus (Miocene of Lompoc, Calif.), P. priscus (Miocene of Shaktoolik Hill California), and P. kanakoffi (Pliocene of San Diego, California). The Laguna Hills specimens are immediately distinguishable from the humeri of P. diatomicus on the basis of the lower position of the ectepicondylar process with respect to the distal end, less marked, but seemingly valid distinction from P. kanakoffi is seen in the more distally placed

887
3556

Loc. L. Acm 1945 4.15'66
El Toro Limestone
Pupfish

Ulna

	prox sh	dist sh	dist. sh	dist end a	in dep sh b	sh c	dist end d	proxim sh e
Br/depth sh								
mid	3.15 × 3.4	4.1 × 3.0	—	—	—	—	—	4.4 × 3.6
near distal	—	4.2 × 3.2	4.4 × 3.2	4.4 × 3.4	4.5 × 3.3	4.2 × 3.2		4.0 × 4.1
gr Br distal thumph carpal fac.	—	—	7.7	7.9	7.9	7.5	8.0	8.6
Br. dist. trochlear arc	—	4.4 ap?	4.3	4.2	4.3	4.3	4.4	4.2
Depth dist (ext'ly	—	5.4	5.7	5.7	5.8	5.65	6.0	5.35
Br. across proximal	—	7.0	7.0	—	—	—	—	7.0 7.3
Dept prox. end	—	7.8	7.8	—	—	—	—	7.5 7.4

Chars.
① olecranon more blunt than in quothon, more as in gilseus

Tarsus

	prox end	prox end	dist. ends		San Diego Type		P. diat. sacrum pr.	P. gilst. 5.58
Br. prox	6.9	7.1 (7.3 +)			6.5	6.7	6.9	— 6.3
Depth sh ext	4.5	4.3	5.1	shaft 4.1	4.4 3.7	?	3.5	4.2 3.5
int.	3.8	3.8	3.5	2.9	3.0 3.9	?	3.1	3.1 2.2
Br. sh (ant'ly (prox'ly)	2.9	2.8	3.4	2.6	2.4 2.7	2.9	2.7	— 2.6
Br sh (dist'ly)	—	2.9		2.5	shaft only 2.7 2.5	?	2.5	— 2.2
Br. dist end	—	7.2		—	6.5	?	—	— 5.65
Br. ext + mid trch.	—	5.0		—	4.5?	?	4.6?	— 4.9
Depth mid trch.	—	5.0		—	4.3?	?	—	4.5? 3.8

Another

Characters of Tarsus

① Prox end: hypotarsus (ant side) is not continuous with post. edge of shaft as in P. gilsonis but slightly median to that edge & below the ext calc. ridge the shaft is swelled

② Ext side of shaft is deeper than San Diego.

= P. diatomicus

Rec. from Gilsonis has an ant. but not as marked

Magnitude Pupfishes — Carpus

	El Toro	Poposthes 5.58
Depth prox Hum M1		
ext	8.2	8.9
Int M1	5.7	5.3

Tularosa?

Most fossil shearwaters are best known from the humerus or from the tarsometatarsus

OR

Dec. 1945

Procellariidae — Shearwaters

With the exception of Puffinus diatomicus all fossil shearwaters have been described from either humerus or tarsometatarsus. P. diatomicus was described from a nearly complete skeletal impression in diatomaceous shale. Fortunately, however, certain details of humerus & tarsometatarsus can be observed from neuve casts made from the impressions. Among the 49 pages of shearwater bones in the Laguna Hills material there are seven humeri & 12 tarsometatarsi. The size range suggests that all represent the same species which was a small form such as present-day P. griseus & P. gravis. Among the North American fossil shearwaters, P. diatomicus (Miocene) and P. kuroshioi of the Pliocene were probably comparable in size.

	Laguna H.	P. diat.	P. pacificus	P. kuroshioi	P. opisthomelas (11)
Br. distend humerus	7.0–7.5 (3 bones)	7.1	7.4–7.5	7.3–8.0	7.1–7.6 OK
Br./dpl. humerus	3.0–3.3/5.9–6.0	11.3–12.*	3.5–3.6/6.3–6.6	3.0–3.5/5.3–5.8	3.2–3.4/5.0–5.8
Dist. tars.	9.0–9.4		9.7–9.8	9.2–10.0	9.1–10.3
Br. tars.	2.4–2.8	2.4?	—	2.6–2.9	2.1–2.5
Br. prox. end	6.8?–7.1	6.8?	—	6.7–7.1	6.0–6.7

* dep. avail. from neuve casts made Howard 1949.

P. arvernensis small, P. antipodum & P. anglitanicus large

Distinction from P. diatomicus is evident in the humerus on the basis of the position of the ectepicondylar process close to the distal end, & in the tarsometatarsus. Distinction from P. kuroshioi is most clearly shown in the hypotarsal area of the tarsometatarsus; in the Laguna Hills bones the internal calcaneal ridge is slightly medial of the internal surface of the shaft, whereas in P. kuroshioi the ridge is continuous with the lateral border of the internal shaft; the external foramen beneath the external calcaneal ridge is more prominent in the latter & the area around it more depressed.

The tarsometatarsus of P. opisthomelas is not known. Distinction from the humerus is not marked, but

El Toro
shaft mid-end 50.0–55.0
L R R 3.0–3.3 } 4 bone
dist. mid condyle 5.9–6.2 }

B. to depth of humeral close to distend

3.3×6.2 = 53.2 3.3×6.0 = 55' 3.0+6.0 = 50.0 3.3×6.3 = 52.5' 50.0–55'

Shackleford Hill (3 measurable) 54.5'–55.6 90

Same meas
3.9–3.6 } 54–55.6 90
6.1–6.4 }

3.6×6.6 = 54.5' 3.4×6.1 = 55.6 or 3.5×6.3 = 55.6

Mitchell
4.1×7.2 = 58.0 ref dimplett
3.5×6.0 = 58.2 Tyler

Kanahyin
3.0–3.5
5.2–5.8
52–54 90

3.5×6.4 thick = 54.6

P. feltrami 3.6×7.4 = 48.6

same meas
P. gustho.

3.2×5.6 = 57.3
3.1 × 5.5' = 56.4
3.0×5.8 = 51.6 ✓
3.2×5.8 = 55.1
3.2×5.6 = 57.3
3.2×5.8 = 55.1
3.2×5.6 = 57.3
3.4×5.9 = 57.4
3.2×5.5' = 57.4 ✓
3.2×6.1 = 52.5'
3.3×5.8 = 57.0

51.6–57.4

Proportions of shaft, slightly more slender in Lapunah, 3.0–3.3 (3.4–3.6 Ramis)
but depth ~~about the same~~ 6.0–6.3 (6.1–6.6) ratio 50–55 (54–55.6)

	a ext diam	c ext diam	C max diam	BA	CA
Shackleford	6.7/6.3	6.6		94%	98.5'
553 apist.	6.3/5.6	6.5'		89	103

El Toro 1 6.9
2 6.1
3 6.8
4 5.7 5'
5 5.8
6a 5.7
6 5.6
7 6.4
8 6.9
9 6.3
10 6.6 5'

1/6a	93
1/6	95'
1/4	95.7
1/5'	96.5
2/6	93
2/5'	95
3/4	84
3/5	84.4
3/6a	82.5

Puffinus

6.8.66

For Jaeger 1995
El Toro
Laurie Wolk

four upper ends coracoids

Distinguishes from P. gristhomelas by ~~straight~~ ventral margin below furcular facet ~~straight~~ (lacking marked protuberance of P. griseus)

= thinly angular and proceeding directly from ventral edge of furcular facet without marked protuberance; ~~close to P. creatopus~~ deep longitudinal groove below furcular facet distinctly marked in 3, more generally depressed in 1. Chars. of coracoid somewhat more like that of P. creatopus = P. griseus.

Tarsometatarsus prox end internal calcaneal ridge + Akeshami terminates slightly medial to posterior border of shaft — as in P. griseus differs from P. gristh = P. creatopus in which the int calc. ridge = the post. border of the shaft are ~~continuous~~ set a bit with each other

Ulna (prox) ~~with from extended angle to shaft as pictured~~ deep narrow depression below articular surface on palmar side bounded ext'l by ridge extending shaft from ext condyle as in P. gristho. In P. gris = P. creatopus the ridge is shorter + area below olecrytal is broader + shallower

1821 = 5359
1982 = 5346

MNA Sabine Contrib # 107

LAM EL 1945
Lasmewald

Puffinus

The distal ends of humeri are close in size to *P. opisthomelas* as is true as well of three no Amer. fossil shearwaters, i.e. *P. diatomicus* and *P. priscus* (Miocene) and *P. kanakoffi* (Pliocene). The Laguna Hills specimens are immediately distinguishable from *P. diatomicus* on the basis of * less distance of the ectepicondylar process above the distal end. Less marked, but seemingly valid distinction from *P. kanakoffi* is seen in the slightly greater relative depth of the shaft and the + relative lesser distance from distal end to prox. tip of the fossa attachment for the ant. articular ligament. Distinction from *P. priscus* is less clearly marked although the Laguna Hills humeri seem slimmer with slightly less elevated ectepicondylar process and attach. for ant. art. ligament facing more distally palmad (*P. priscus* more laterally) due to [illegible] two additional

Left fragments of tarsometatarsus (3 prox ends, dist. end, + fragments) differ from *P. opisthomelas* in greater depth of shaft and placement of internal calcaneal ridge slightly median to surface of shaft. Approach is closer to *P. diatomicus*. Tarsus is not known from the type locality (Shaubarth Hill).

This element in *P. kanakoffi* [illegible]

3 prox ends of tarso.

EPTNO by depth 51.6 53.6 53.4

* slender ectepicondylar process, placed closer to the distal end,

\+ less prox. extent of the attach. for the ant. articular ligament,

8 dist. ulnae
4 prox "
1 " shaft (Laye)

4 upper end coracoid
1 dist " femur
2 1/2 " tibia (1 is anc. frag.)
3 scap

? *P. bulleri*?, ?

P. nicrenularis was apparently considered by Condon as a synonym of *P. opisthomelas* + *P. conradi* + *P. mitchelli* + *P. wintlei* by Loomis

SD Toro
5.25.66.

Diomedea sp.

A small fragment of the shaft of a tarsometatarsus near the proximal end (LACM) is referred to the genus Diomedea. It is impossible to assign the specimen specifically. Its size, which is close to that of D. nipiens, precludes the possibility of assignment to either of the species described from Waitotara Hill. Diomedea californica is much larger, D. milleri much smaller.

for 1945

(3)

Procellariiformes

This order, which includes albatrosses, shearwaters, fulmars and petrels, is the most abundantly represented group in the collection. Two families and three genera are identified, from 52 or 32 bones

Family Diomedeidae albatrosses

Diomedea sp. (2)

A small fragmentof the shaft of a tarsometatarsus near the proximal end (LACM no.) can be referred to the genus Diomedea but a species assignment is not practical. In size the tarsometatarsus is similar to this element of D. nigripes, and is, therefore, too small to be assigned to Diomedea californica from the Miocene of Sharktooth Hill, and too large for D. milleri from that/locality. same

phalanx 1

Family Procellariidae, Shearwaters, Fulmars, Petrels

Puffinus 48 bones

Shaft humerus (dark) 1.27.65
" proximal " (") 12,64
prox humerus " 12,64
" " med " ✓
dist " " "
" " dark "
" " med 1.18.65 ✓
prox ulna dark
prox ulna med 12.18.64
prox " med 12.64 ✓
12 dist " dark "
7 dist ulna dark "
1 dist radius " "
3 prox tarsi " "
2 dist " " "
1 " " " "
3 " " med " ✓
4 top coracoids dark "
2 prox scaps dark "
1 dist femur dark "
1 dist tibia dark "
2 ung phalanx " "
1 — quadrate med " ✓
1 curvatum " " ✓

1 distal tarsus dark 1.18.65 ✓
1 prox " " med " ✓
1 prox scapa dark "
1 " " dark 12.24.64 ✓
1 " ulna dark "
1 dist prox tarsus dk " ✓
1 " " carpus dark "

Keep Thead ins

OVER

Pelecaniformes

Odontopteryxia

Seaborder

bony-toothed birds

Osteodontornis?

A fragment of lower mandible bearing two bony "teeth" certainly belongs with the odontopteryx birds. The specimen is narrower vertically than in the 2 known specimens of Osteodontornis, but possibly represents the extreme in this genus which has not been clearly determined in the other specimens. The teeth measure 6.8 mm. & 4.8 mm. in length at their bases respectively. The smaller of the two is as tall as long and its height is nearly complete. Its pointed tip angles sharply backward and is blunt and eroded and the larger tooth is blunt and eroded and probably had a height of 8 mm or more.

Compared with the description of Osteodontornis orri (Howard 1957:12) the smaller tooth in the Tapia specimen may represent an intermediate size projection between two major projections in O. orri but larger than the largest projections in O. orri but larger than the largest projections in O. orri but larger than the largest

Loc 1945

Family Procellariidae, Shearwaters and Fulmars

Puffinus, sp.

Forty-nine bone fragments represent the genus Puffinus, and are probably assignable to the same species. All the chief limb elements are represented, also coracoids, scapulae, wing phalanges, and a cuneiform and a quadrate.

Previously recorded fossil shearwaters are best known from the distal end of the humerus or from the tarsometatarsus. Among the Laguna Hills shearwater bones are seven fragments of humeri and 12 fragments of tarsometatarsi. The size range is suggestive of a bird the size of the living P. opisthomelas.. Among North American fossil shearwaters, P. diatomicus and P. priscus of the Miocene, and P. kanakoffi of the Pliocene were probably of nearly comparable size. P. conradi, P. inceptor, P. mitchelli, and P. felthami were larger, P. from the Miocene of Florida, considerably smaller.

Distinction from P. diatomicus is evident in the humerus on the basis of the position of the ectepicondylar process closer to the distal end. Distinction from P. kanakoffi is most clearly shown in the hypotarsal area of the tarsometatarsus; in the Laguna Hills bones the internal calcaneal ridge is slightly mediad of the internal surface of the shaft, whereas in P. kanakoffi, the ridge is continuous with the border of the shaft; the foramen beneath the external calcaneal ridge is more prominent in the tarsi at hand, and the area around it is more depressed.

The tarsometatarsus of P. priscus is not known.

The type humerus and referred specimens of humeri, ulnae, and coracoid from Sharktooth Hill and an ulna recently found associated with a humerus which is presumably referable to P. priscus, appear to be slightly larger than those from Laguna Hills, and it is likely that a different species is represented. At the present stage of knowledge of the birds from the two localities it would be misleading to attempt to establish clear distinctios.

For. 1945 Sagura Helo Loc

Procellariiformes

LACM Contrib Sci # 142

type cat
Puffinus puffinus

P. barroni

P. cathomi

P. diat ?
□ 2706
Venturi
76.7

P. diat
Σ 705
Shuguan Oatie

Puffinus
~~creatopus~~
opisthomelas

Skull

refused

Humer			
lesath (81) →	82 ?	—	?
cond. 7.0 →	7.2	—	7.0
dpth int 7.9	8.3 ?	→	7.9
" ext →	6.5 ?	—	
ext 7.2			
dia 10.0 inc	11.0	—	10.4
	10.2	—	10.0
radius 9.7	9.9	—	9.4
dpth sh 6.2	5.75	—	5.9
Tibiotar.			
int 10.9	10.6	—	10.1
ext 10.7	10.1	—	9.5

77.4 - 85.0

M. 9.4 5
9.1 — 10.0

70.6 - 78.6

62.5 74.5

Ulna 40.3 44.3

carpo 28.7

femur 64.0 70.3

tibia 46.5 51.2

tarsus

May 1978

Measurements of Paffinia didymicus

	Type mold	Tyler Miller meas.	"B"	Pl 7a mold	skulls unfused mold & comstein	Pl 2 mold cotype unfus.	cotypes mutilated	San Pedro specim	SBM NH
Skull total	—	90.	79.3	79.6					
low. jaw		—	72.5	75.6					
Humerus								Hymer 82.2	87.2
length	80.2	80	81.6 unfused 81.35 mid.	77.0	78.1	82.3 82.9 → 77.8	82-84 cotype		
gr. dist. condyle	26.5			8.5					
depth int. cond					6.5				
" ext "					11.2				
diag. depth								9.9	10.0
depth (straight)	10.3				9.7 or 10.2 13.0 along curve	8.5 10.3 along curve			6.6
"Intercotyl" ratio to length	11.7 14.5 along curve		10.2 or 10.4 along curve						
depth sh.	7.0		6.3	6.7	6.8				
Int trochl. compression				10.7					
int	9.5	—							
ext	9.2								
Radius length ana.	28.4	27				gr. ana. 15.6 27.3	26-27 cotype		
Ulna length to coct.	73.7	75.0	74.6 76.8	69.4 71.0	69.8 73.7	75.0 78.6?	76-79 cotype	75.7 (72.0 pub.)	85.7
length to olec.	—	—						—	45.5
Carpo length	—	—	44.1	41.4 8.5	43.0 9.3	45.4	45-46 cotype		
gr. w.	—	—	—						
Humerus int. length	30.4	30	—	31.6?	—	—	33 —	—	30.5
ext. length	33.9								
Tibia length to artic.	73.5	73	69.8	70.7	70.6	—	69.1	72.2	
length to crest	85.8	87	—	86.0	—	—	85.7	84.0	
gr. dist.	6.5	—	—	5.6	depth art 6.7	—	depth art 9.0		
Tarsus length	—	—	51.7	49.7	52.0	—	— 53	54.8	51.6
Toes length	—	—	54.2	53.8	54.8	—	— 53	53.7	
Wing Phal.			21.0	19.4	20.6	19.6	21-21		23.7
Pl, dig. 2			19.7	22.4	21.9	20.7	21 —		25.5
Pl dig 1									

May 1978

Br dist humerus

P. mitchelli	17500 complete only 8.0-8.3 or 9.0-9.3 (cal acad spec #5224) 8.6 - 9.0 9.1 #17600	17500 6190-6390 Shalt Breadth delta 4.1 4.2 6.7-6.6 56.5 58 57 % 3.9-4.0 / 6.95-7.00 6:8 = 5990 4N acad #5224	ht ecteniconus 11.0-11.4 type ref 17010 10.9 - 11.2	Lusk loc 16225 #17500 98.3 ↗
P. pusens	7.3-7.5 7.4 #17502 (from 1945 17548)	51.6 - 52.3% 3:2-3.4 / 6.2-6.5	type 9.8 - 9.9 ref	81? #44658 loc 16225
P. conradi	9.2	87% 5.8 5.1	12.5	—
P. incepta	8.75	3.7 72% 5.1	10.3	—
P. calhounii	type 17508 17539 7.0 7.1	50.8% - 55.0% 17508 17539 17508 17539 3.1-3.3 - 6.0-6.0	type ref 9.6 - 9.6?	—
P. barnesi	type 7.7	6190 3.5 - 3.7	9.5	83? 67.0 K, deltoidal
P. diat.	type 7.5? 7.1 7.3? Stanton #4 8.8	3 streams 6.3, 6.4, 6.4 ? type 7.0 ? 6.2 ?	#29078 cal acad sel 11.5 - 9.9 10.2 ref. 8.5 coffee p. 12	Platt 77.0 Cobb 85.9 82.2 80.3 Cobb D CAS 80.4 type meas by HI
Tefrosquet		6.6 57% 50% 2.7/5.4 3.2/5.6 54% 66% 3.5/5.3 3.4/6.0 56.6% 3.3/6.1 ~~52% - 50%~~ ~~3.1-3.3 - 5.4-6.5~~		87.2 64.3 type to dist-d deltoid 77.5-85.1 (80.5)
P. kanabowi	7.3 - 7.4		8.9 - 9.6	
P. feltham	8.5	52% 3.7 - 7.1 3.5 51% 6.8 type	9.9? #1	90?

Humerus ulna campus caracal from Inhambane

P. priscus 44458 Lr 16.2 cm → 81 mm
+ 260 Waterberg → prox 15.2–15.4
from Lr 1945 → dist. 7.5

priscus type — dist 7.3
tr ectep 10.0 or 9.7?
ratio tr dist tr 48–53%

P. calhouni — dist tr 7.1
ratio tr dist tr 56%
distance to ectepi cond. 9.3
tr. prox 6.4
depth 7.7
→ tr prox 6.6

P. diatomicus type — depth 75.0–84
dist tr. 7.1
tr ectepi 12.0
71–79.0 41–46

P. feltmani — dist tr. 8.5
tr ectepi. 11.0

P. kamatrifis — 7.5–7.6
tr ectepi. 9.1–9.6

SBMNH 3129 — 87.2 depth
ulna 85.7 depth
campo. 46.0 dist tr

P. barnesi — 80?
distbr. 7.7
ratio br to depth br = 61%
depth 70.8
prox = 6.5 br

(1) Check all P. diatomicus specimens from Inhambane. Are they all same sp? Compare br to depth of humerus if possible.

(2) Examine P. diat. from Cabrillo Beach (in LACM museum?)

(3) Measure ulna + humerus of aleid (?) from Cabrillo beach.

(4) Examine P. fitchi from Tejas Quet + compare with P. barnesi, priscus, mitchelli, calhouni + inaffina as well as diatomicus.

(5) Examine skull from Acm 1752 (# 500,) check to humerus

Position on shaft meas. # 1

12.7 mm Puffinus griseus

13.0

12.7

11.8

12.6

12.6

11.8

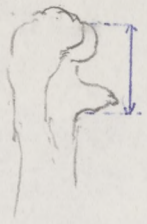
12.0

13.1

12.8

12.5

12.2 - 12.4



all taken from left side.

11.8 - 13.1

Tip to opposite profile of bone

15. mm

15.0

14.9

14.7

14.9

15.2

14.7

14.5

14.3

15.6

14.3

14.4

	Puffinus priscus (Type)	*P. mitchelli*	*P. diatomicus*	*P. griseus*
ht. ectepi. process (Howard's diagram)	10.2 mm	10.50		12.6
length ectepi. to base of process	3.7	3.3 (?)		5.43
breadth across ectepi. process	3.2	5.1		4.3
Shaft diameter	+ — 6.4	6.7		7.1
Total length humerus			81.5 —	106.85 —

1 = ht of process (ectepi condyle) above ext. condyle (see diagram next page)

(2) length of process to its base (not shown on other sheet for griseus

(3) Br. across base of process

Ratio depth sh. to ht proc. 62.6% 63.7%

Nov. 24/61

BERKELEY: MUSEUM OF VERTEBRATE ZOOLOGY

Dear Hildie

Greetings to you + Henry this fine morning! I have so much for which to be thankfull! Please join me this day.

The types of P. diatomicus, prisicus and Mitchelli are before me and I've done what I could in what you asked. The Lompoc slab has an undercut area that prevents the measurements. I pressed plasticene into it and got some results that are approximations only. I send them to you in small box. Put them on ice over night and they will be quite hard.

Also took a dozen skeletons of P. grisens and measured position of the process. You will see that there is much variation although total length of humerus was strikingly constant. All measurements taken of left humerus by one man, one calipers, on one morning. (with one eye).

Shape of process was remarkably constant.

Hastily Padre

Deus vobiscum

This isn't exactly a letter, Padre! Thanks for yours. Hope you received the 10 copies of your paper. Love, Hildegarde 11.3.61

From handwritten list (by Loye Miller) with Lompoc material at UCLA

(List included all Lompoc specimens; I have selected only those pertaining to Puffinus diatomicus) Pencil notes mine. HH

U.C. Berk. □ 26541

1. Puffinus diatomicus -- Type -- Berkeley

Lac M has cast

2. Puffinus diatomicus -- Jordan original (proposed Mergus diatomicus) returned to Jordan at Stanford. What part of skeleton represented? Rather complete as I recall. (See also Table of measts in my 1925 paper

Is this a reversed Type? NO

3. ✓ Duplicate Puffinus diatomicus -- head, neck, sternum, coracoid returned to Stanford cotype "C" Stanford

Cotype! Stanford Yes.

4. ✓ Puffinus diatomicus -- cotype wing deposited at Stanford (cast, reverse, at Lacm)

UCLA cast

L.A. Mus. gift of L. Miller ?

13. Puffinus diatomicus -- almost complete, except head. ✓ Received September 1924 from Jordan. (following this entry, is written in pencil "L.A.Mus!") — Yes. I donated this to LA Mus. ✓

LACM

✓ 14. Puffinus diatomicus -- humerus and part girdle Received October 1924 from Jordan

Stanford cotype "D"? "Palatype"?

illus. Miller 1925 Pl. 7 A yes

17. Puffinus diatomicus -- most complete yet taken from Lompoc ✓ Received January 12, 1925

UCLA Cast

Now at U.C.L.A. unrecorded. Received too late to be included in original description

21. Puffinus diatomicus -- nearly complete -- August, 1926 ✓

UCLA

True

Note: Which among these would be cotypes 2 and 3 and where are they? From list of measurements, Cotype 2 must have been a pretty good specimen but without head [might this be #2 above?], and in cotype 3 only the coracoid was measured [would this be no. 14 above? Probably] If so was it returned to Jordan? Probably not

No. Lompoc slabs of Puffinus were not reverses as I recall.

Is #3 above a reverse of The Type?

Padre - I have 4 specimens of Miocene Puffinus now to be recorded. I would much appreciate your help in clarifying the whereabouts of the originally described material. Also do you know of still other specimens (other than the San Pedro one you recorded + the Lompoc one Bob Orr recorded; and, of course, I have your recent description from Shaktoolik Hill)? Hildegarde

UNIVERSITY OF CALIFORNIA

DEPARTMENT OF ZOOLOGY
DAVIS, CALIFORNIA

Dear Hildée

Back at my Davis desk and am sending additional data on Puffinus of several species not included in my former letter. Numbers are such as you requested in your letter of Nov. 9/61

Found on my desk a blank from Guggenheim Foundation to be filled out in your behalf. Needless to say I am most happy to do this with favorable recommendation. The project is important and researcher the best qualified in this world or the next! More power to you!

Love to you

Padre

28/Nov./61

UNIVERSITY OF CALIFORNIA

DEPARTMENT OF ZOOLOGY
DAVIS, CALIFORNIA

Dy Dear Hildegarde

Your latest note (11-3-61) has me stumped. I never was cut out for a Museum man and have no exact record of all slabs of Lompoc birds. Memory has gotten "fuzzy" but I do recall that all slabs at UCLA had data marked on the slabs and except for one slab deposited at L.A. Mus. and those returned to Jordan, none were disposed of. At that time Jordan wanted all to be left at Stanford because Stanford had a Museum. I was not too confident of that Museum so for as preservation of Avian fossils was concerned so talked him into placing types at U.C. Paleo. Mus. He was broad minded enough to see it my way and was content to have the three slabs deposited there. Others were given to me and the field of collection and research was turned over to me by Jordan. I made several trips to Lompoc and paid out of my own "shallow" pocket for specimens and shipment.

The Lomita Quarry that produced Sula stocktoni later produced a fairly complete slab of P. dialomicus but it was not obtainable (The guy wanted it for his office wall) I did not publish on it and lost track of it).

I seem forget how many slabs are at UCLA and the collections have all been shifted since my departure.

Yes, thank you. The extra 10 copies of Anacoma paper arrived and several sent off (New Zealand + Australia) No duplicates yet of Shark tooth Hill paper

Love to you

Pedro

P.S. Planning to go to MOZ on Nov 20-25)

Shanhaotte mio. Hemmer GOOD Lag. Halb mio Puffins

LARGE Plio

	pusios		mitchelli		felt.	kanahoffi											
	Type P. pusios cast	Reb P. pusios Shanh form 17502	P. mitch type cast	P mitch reb shanhtt 17600	P. felthem type	cotype P Kana koffi 2120	P. Kana koffi 2160	P. diat. Type	P cal howii type 17508	P cal howii reb 17539	P. pusios ? 17548	shaft 17542		Cedrosa? tros Dist hemmer 15409?			
a Dist Bn. condefles	7.3	7.4	8.4+	9.1R 9.0L	8.5	7.3	7.6	7.3?	7.0	7.1	7.4						
b Depth int cond.	—	9.1	—	10.4 10.3	10.0	8.4	—	7.8	8.0	8.0	8.9						
c Dn ext "	6.6	6.9	7.3	8.4 8.0	7.3	6.1	6.3	—	6.1	6.12?	6.7			7.6			
d Ht ectopi cond ^ from above ditto	9.8	9.9?	10.9	11.4 11.2	11.1	8.9	9.6	11.6 10.7+?	9.6	9.6?	?			prox. some 11.0?			
e Ht / Dn lig. Serifs	3.8/1.8	3.2/1.7	4.4/2	4.6/2.4 4.0/2.2	3.2/1.9	3.4/1.6	3.4/1.7?	—	4.1/1.9	3.7/1.8	3.7/1.9						
f Dist. to tofe b lig. surface	6.7 inc.	6.9	8.2	8.3 8.1	8.6	6.7	6.8	6.5	7.0	7.1	6.9						
g above Dept antSh	4.3	4.4	4.5	4.8 4.8	5.2	4.3	4.4	3.7	3.8	3.9	4.5	4.1					
Bn / depth h Shaft	3.2/6.2	3.4/6.5	3.9/6.8	4.0/7.0 4.0?/6.9	3.7/7.1	3.0/5.9	3.3/6.45	—	3.1/6.1	3.3/6.0	—	3.2/6.1		4.5/8.3			
* Ratios ca	90.5%	93.2%	86.8%	92.3% 88.8%	85.8%	83.5	83.8%	—	87%	86.4	pusios 90.5						
gb	—	48.4	—	46.1 46.6	52.0	51.3	—	47.5	47.5	48.8	?						
fa	91.8	93.3	97.6	92.3 90.3	101.0	92.0	89.5	89.4	100.0	100.0	pusios 93.3						
* da	134.1	134.0	130.0	125.1 124.6	130.5	121.8	126.1	146.7	137.1	135.1	—						
e/e recess	47.4	53.2	45.5	52.3 55.0	35.6	47.1	50.0	—	46.4	48.6	51.4						
h/h	51.5	52.4	56.2	57.1 58.0	52.1	52.6	53.6	—	50.8	55.0	—	52.5		54.8%			
* ba	—	123.0	—	114.2 114.3	117.8	115.0	—	107	114.1	112.3	pusios 120	—					
* ga	59.0	59.4	53.5	52.8 53.4	61.1	58.9	57.9	50.6?	54.3	54.9	pusios 60.7						

Pliocene sheaumates

10.27.61

	Corna del Mra P. latthain type		San Diego P. hazardi													P. pinus	P. muricata	P. insignis
Humerus		cotype	#	X	X	X												
		21.20	2516	2116	2114	2160	2126	2572	2516	2444	2328	2648	2643					
Htect. epi humerus prox	9.9	9.4	8.8	9.8	8.5	9.8				9.3						10.2	10.5	9.9
Br dist	8.4	7.3	—	8.0	7.7	7.8				7.9						7.5	8.5	10.0
Depth sh.	6.8	5.3	6.0	5.4	5.6	6.1			5.5	5.1	5.7	5.6	5.8			6.3	7.0	6.0
Br. sh	3.5	3.2	3.4	2.7	3.2	3.3			3.1	3.2	3.1	3.4	3.2			3.5	4.2	3.5
Length hum.		80	84.9	—	—	—								80.				
" tarsus							46.8	45.4		[redacted]								
Dept sh to Htect epi	68.7%	72.4	68	67.3	72.4	78.2				64.4						61%	64	60%
Tarsus length/depth on humerus	51%	66	56	50	57	54				62	+	60	55	45.2-43.0		55	60	58
Ratio dist to Htect epi + Br dist	1.17%	1.28%		1.22%	1.10%	1.25%												

P. affinis
Humerus

P. mitchelli?

	Type P. inaptus at Cal Acad Sci	P. conradi	P. pucus	P. mitchell?	= P. sp. Acad no. 5224 Shasta county Hill	✓ P. diat. onusus Type	P. feltham type	P. Kanak affi cotype humerus	✓ P. diatomicus #29078 at Cal acad sci	✓ P diatomicus cotype at Stanford Mikin cotype?	✓ P diat. Stanford cotype Pantopus mitchelli?	✓ P diat. cotype Bogmell Stanford	Referred "paratypes" Mt	P diat Sherman Oaks	Wood Creek Hills	Ventura CO	Sta B
Br. distr. condyle	8.75	9.2	7.3	8.6	9.0	7.5 (7.7?)	8.5	7.3	8.~~7~~	8.8			7.5 - 8.0				
Ht ectepi-pus above dist. end	10.3	12.5'	9.7	11.1		11.5 (6?)	11.0	9.4	9.9				9.2 - 10.0				
Ht. base of ectepi cond-pus.	3.9	6.7	3.2	3.4													
Length ectepi pus.	3.45'	5'.3	4.4	3.7													
Depth shaft. X	5.9	7.8	6.3	7.1	6.8	6.2					least 6.35						
Br. shaft Y	3.7	5'.1	3.2	4.15'	4.0		3.8	3.5				5'.6	3.0 - 3.5'				
Br. shaft above pus ectepi	4.5	5.0	?	?	4.7												
Depth ext. cond	7.30? 9.5	8.3	6.6	7.9													
Ht ext cond	4.0	7.3		5.0? cart	4.9												
Ht int cond	3.3	3.7		3.7 cart	3.9												
Depth int cond	9.6	10.4			—												
Gr. br. ext cond.		3.7															
Br ext cond tip		2.2															
Ratio Y/X	62.7%	65.3%	56.7	57.7	58.7												
Length humerus						77.5	est.		82.2	83.9	80.3	—	80.5 - 85.0	→	73.8	—	87.2
ulna length						71.5			75.7	77.8	—	71.6		74.5	70.0	67.3	85.7

The recent description by Loye Miller (Condor, 63: 388-401) of two new speciesof Miocene Puffinus from Sharktooth Hill, Kern County, California, prompts me to place on record four specimens of shearwaters from four other southern California Miocene localities. All are partial skeletons preserved in shale as imprints or combined imprint and bone fragments. With one exception all previously recorded Miocene shearwaters preserved in this manner have come from the Lompoc diatomaceous shales (Santa Barbara County) and have been assigned to Puffinus diatomicus, for which Lompoc is the type locality. The one excepted specimen is from ~~the coastal area of~~ Los Angeles County; this, too, was referred to P. diatomicus (Miller, Publ. Univ. Calif. Dos Angeles Biol. Sci., 1 (5):74-75). Two of the specimens now at hand come from the San Fernando Valley, Los Angeles County; one from Balcom Canyon, Ventura County; and one from Pepusquet Canyon, Santa Barbara County.

Like Puffinus diatomicus, these four specimens resemble Puffinus opisthomelas in general conformation of elements and are therefore distinct from P. inceptor Wetmore (1930, Proc. Calif. Acad. Sci. 4th ser. 19 (8): 86-87). Of this latter species, known only from the distal end of a humerus from Sharktooth Hill, Miller (op. cit., p. 400) comments "were it a bird in full flesh and plumage today, it would doubtless be assigned to a separate subgenus at least." ~~Only~~ One of the four agrees with Puffinus diatomicus in all essentials. The other ~~three~~ differ from that ~~species~~ ~~either~~ in ~~size or~~ proportions. It is impossible to make direct comparison between these specimens (preserved largely as imprints) and the types of Miller's P. priscus and P. mitchelli (known from a single distal section of humerus, free from matrix). Nevertheless, the recording here of such information as can be gleaned from their proportions may prove of value if and when more material may be forthcoming from the Sharktooth Hill site.

The smallest of the new specimens (L.A. Co. Mus. no. 2706) was collected in 1956 in Balcom Canyon, Ventura County by Eugene Nicholas, Blanche Nelson andHarry Shetrone. The skull, leg bones and part of the wing are represented, the limb elements on one slab, the skull on obserse and reverse slabs. The diagnostic proportions of leg to wing bones and ulna to skull which distinguish P. diatomicus from P. opisthomelas (see table 1) are in agreement with those of P. diatomicus; humerus and coracoid, however, are either incomplete or missing and can therefore not be included in measurements this statement. In actual size the measurable individual elements (six) are 12-15 per cent shorter than the maximum for P. diatomicus, and 2 - 7 per cent smaller than the minimum of that species. If no. 2706 does represent P. diatomicus, the fossil specieshad a greater range in size than is evidenced in a series of 12 skeletons of present-day P. opisthomelas. In this Recent series the minumum varies from 9 - 11 per cent of the maximum depending on the element. Possibly more than one race of P. diatomicus was present in the Miocene.

Table 1

Lengths of elements (in mm)	P. diatomicus	P. opistho	#2706	size 2706 rel. to P. diat. max.
Skull	79.6 - 90.0 (2)	73.3 - 82.5 (12) 11%	76.7 ap.	96.7 - 85.1
ulna	71.0 - 79.0 (6)	70.6 - 78.6 10%	67.5	95.1 - 85.6
carpometacarpus	41.0 - 46.0 (4)	41.5 - 46.5 11%	40.3	98.2 - 87.7
femur	30.0 - 33.0 (3)	30.1 - 33.8 10%	28.7	95.7 - 87.1
tibiotarsus	68.8 - 73.0 (6)	60.5 - 66.3 9%	64.0	93.0 - 87.7
tarsometatarsus	50.0 - 54.0 (5)	42.9 - 47.4 10%	46.5	93.0 - 86.3
Proportions (in %)				
ulna / skull	83.3 - 89.3	92.0 - 101.1	88.0	
tarsus / ulna	66.3 - 70.5	58.5 - 63.3	68.7	
tarsus / tibia	72.3 - 77.2	69.5 - 71.7	72.6	
tibia / ulna	88.2 - 97.4	83.6 - 86.7	94.7	

Assign tentatively to P. diatomicus?

In making the following analyses, the size and proportions of Puffinus diatomicus are based on Miller's measurements (1925, Carnegie Inst. Wash. Publ. 349, p. 112) of the type and cotypes, and the present writer's measurements of Miller's (1935, p.) San Pedro specimen, two specimens from Lompoc in the collections of the University of California at Los Angeles, studied assigned by Miller (one of which was illustrated, 1925, pl.7A, but not included in the list of measurements), and a third specimen from Lompoc identified and presented by Miller to the Los Angeles County Museum in 192 .

The smallest of the new specimens (L.A.Co. Mus. no. 2706) was collected in 1956 in Balcom Canyon, Ventura County by Eugene Nicholas, Blanche Nelson and Harry Shetrone. The skull, leg bones and part of the wing are represented, the limb elements on one slab, the skull on obverse and reverse slabs. The diagnostic proportions of the skeleton are in agreement with those P. diatomicus; In actual size, however, the measurable individual elements are 12-16 per cent smaller than in the type and 2-7 per cent smaller than for the minimum, of P. diatomicus. If no. 2706 does represent P. diatomicus, the fossil species had a considerably greater range in size than is evidenced in a series of 12 skeletons of present-day P. opisthomelas. Possibly more than one race of P. diatomicus was present in the Miocene.

Second in size is a specimen (LA.Co.Mus. no. 2703) from the San Fernando Valley, Los Angeles County. This was collected in 1960 by Mike Jennings on Old Topanga Canyon Road near Ventura Blvd., Woodland Hills. In this specimen, the main skeletal elements are represented (although not always completely) on several obverse and reverse slabs. The coracoid is distinctly longer than in any except the tibiotarsus specimen of P. diatomicus identified by Miller. All other elements represented are shorter; the tibiotarsus is, at least, shorter than in the type of P. diatomicus.

Mult. femurs Woodland Hills - cont'd

Lt. cremaldcert 16.5 (dcat 13.7 - 14.7)

The other elements represented, with the exception of the femur, barly equal the minimum for Pl diatomicus, or are markedly shorter. The femur is within the size range of P. diatomicus. Unfortunately the tarsometatarsus is incomplete. Its position relative to the broken end of the tibiotarsus suggests, however, that it fell far short of attaining the relatively great length characteristic of P. diatomicus. In this apparent shortness of tarsometatarsus, as well as the relatively great length of coracoid, the specimen resembles P. opisthomelas as distinguished from P. diatomicus. The humerus, ~~xxxxxxx~~ is shorter, but seemingly deeper of shaft than in either P. diatomicus or P. opisthomelas, although it agrees with the former as distinguished from the latter in being shorter than the skull. Admittedly the depth of shaft could be affected by crushing of the bone before the impression was made, but the appearance of the specimen does not suggest extensive distortion. The depth of shaft, as well as size and shape of the ectepicondylar process and its height above the distal condyle suggest ~~possibility of agreement with~~ similarity with conspecificity P. priscus Miller,

actually the type of the latter sp. is 4-5 % larger.

Table 2

Lengths of elements	P. diat	#2703	P. priscus
Skull	79.6 - 90.0	77.3	
Coracoid	22.0 - ~~28.5 (?)~~ 27.0	29.4	
~~Humerus~~	75.0 - ~~84.0~~ 82.6 (3.6.76) ~~86.2 (?)~~	73.8	uncrushed #18140 82.6
Ulna	71.0 - 79.0	70.0	
Carpometacarpus	41.0 - 46.0	40.8	
Femur	30.0 - 33.0	31.3	
Tibiotarsus	68.5 - 73.0	68.7	
Tarsometatarsus	50.0 - 54.0	41.5 (?)	
a Ht. ectepicond.	* 8.6 + 9.6 - 11.6	9.8	10.2 by Mills
b Depth of hum.	5.3 - 5.9 (?)	6.1	6.3
Ratio b/a	61.9 (Ap.)	62.3	61.6

* Attempt to measure max. diameter of shaft

Only as other skel. elements may be forthcoming from Shanidar Hill can we hope for a def. decision.

The largest of the new specimens was loaned through the courtesy of Phil Orr, who collected it for the Santa Barbara Museum of Natural History; the specimen bears that Museum's number 319. It was collected in 1956 at the Tepusquet Canyon quarry (Santa Barbara County) from which the curi curious bony-toothed bird, Osteodontornis orri Howard (1957) was taken. Wing elements only are represented in this slab. The humerus and ulna are longer than the corresponding elements in the series of P. diatomicus noted above. There is, however, one very poorly preserved specimen of shearwater from Lompoc in the University of California at Los Angeles collect ons in which the humerus appears to be nearly as long. Its length varies with the position of the calipers from 86 to 87 mm.; in a previous record of range in size of P. diatomicus (Howard, 1949, p. 188) the figure of 87 mm. was recorded as a maximum length of humerus based on this specimen. Nothing but the over-all length of humerus in this UCLA xxx specimen can be used for comparison with the Tepusquet Canyon bird.

In proportions of ulna to humerus and of carpometacarpus to both ulna and humerus the Santa Barbara Museum specimen differs from the series of P. diatomicus. The ulnar length is slightly over 98 per centof the humeral length, contrasted with 92 - 95 per cent in P. diatomicus; the carpometacarpal length is 52.7 per cent of the humeral length and 53.6 per cent of the ulnar length, compared with a minimum of 53.1 and 55.5 per cent respectively in P. diatomicus.

The breadth of the distal end or of the shaft of the humerus cannot be ascertained in the Tepusquet Canyon bird. The depth of shaft (from anconal to palmar sides) is rather clearly indicated, however, and measures 6.8 mm; measurements on P. diatomicus are difficult to obtain but range from 5.3 to 5.9 on the three specimens that can be measured. The impression of the ectepicondylar process protrudes from the shaft of the bone about 4.6 mm., and is ~~approxi-ately~~ 10 mm. or more above the distal condyle.

Characters of the distal end of the humerus are important in comparing no. 319 with Miller's P. priscus and P. mitchelli. Neither the breadth of the distal condyles or of the shaft can be ascertained, but the depth of shaft (from anconal to palmar sides) is rather clearly indicated and measures 6.8 mm. Ths dimension is recorded as 6.3 mm. for P. priscus and 7.0 mm. for P. mitchelli (Miller, 1961, p. 401).[1]

[1]In correspondence, Miller tells me that this dimension may vary slightly depending on the position of the calipers; he reports a possible 6.4 mm. for P. priscus and 6.7 mm. for P. mitchelli.

The impression in the matrix left by the ectepicondylar process protrudes from the shaft of the humerus about 4.6 mm. and is 10 mm. or more above the distal condyle. Loye Miller very kindly took these measurements for me on the types of P. priscus and P. mitchelli and reports (correspondence) as follows: Length of ectepicondylar process (protrusion from shaft), P. priscus 3.7 mm., P. mitchelli 3.3 (?) mm.; height of ectepicondylar process above distal end, P. priscus 10.2 mm., P. mitchelli 10.5 mm. The Tepusquet Canyon specimen might agree with either species in height of the process above the distal end, but seemingly had a longer process. With the material at hand I do not consider it wise to establish a species on the basis of this small character. It is to be hoped that more material will be forthcoming from Sharktooth Hill which may throw more light on the proportions of the skeletons of the shearwaters described from that area. At such time the specimen from Tepusquet Canyon should be reexamined.

The proportions of the wing bones to one another clearly set the Tepusquet Canyon specimen apart from P. diatomicus. In relation to the humerus, the ulna and coracoid are and 36 per cent respectively longer (98 per cent of humeral length), the carpometacarpus shorter (52.7 per cent) ~~and the coracoid longer~~.

The meager comparisons possible between the Tepusquet Canyon specimen and the other California Tertiary shearwaters show the humerus of the Santa Barbara specimen to be heavier than that of either P. kanakoffi or P. priscus, and to have a shorter deltoid crest than that of P. felthami. Depth of shaft and height of ectepicondylar process above the distal end are close to these measurements in the type of P. mitchelli, but the process protrudes from the shaft more markedly. However, Loye Miller, who kindly took this measurement for me on both P. priscus and P. mitchelli, was doubtful whether the process is complete in the type of P. mitchelli.

Check conradi

The shape of the ectepicondylar process distinguishes the humerus from that of P. conradi. Wetmore (1926 p 463) describes this process for P. conradi as ~~being~~ forming an abrupt angle with the shaft of the bone at its lower margin ~~and being~~ rounding more gradually into the upper margin. The reverse is true of the Sta B. specimen.

Miocene Shearwaters

Puffinus conradi Marsh (Maryland) — very close to P. gravis (O'Reilly) atlantii
Miocene ancestor of)
b. condyle 9.2 mm
2/3 distal — humerus
Belongs to subgenus Ardenna & which P. creatopus also belongs

Puffinus sp. (Maryland)
1/3 distal — ulna (assigned to P. conradi by Marsh)
much smaller than P. conradi (same size of P. puffinus

Puffinus inceptor Wetmore (Calif. Shark Tooth Hill)
1/4 distal — humerus
Size = Wedgetailed Shearwater
Thyellodroma cuneata
Larger than P. diatomicus
Smaller " P. conradi
closely like P. tenuirostris
but bird smaller.
Subgenus Puffinus
(griseus + pacificus also in this subgenus)
Br. dist. 12.2 Br sh 5.9
Ht scapula 4.6
Ht sternum

Puffinus sp. (Calif. Shark Tooth Hill)
1/2 distal — humerus
close to P. conradi of Maryland but smaller

		conradi
Br. dist	12.8	13.4 and 9.2
Br sh	6.9	7.1

Puffinus mitchelli (Shark tooth Hill)
Larger than P. diatomicus

Br. dist.	8.5	80%
Br sh	7.0	
Depth	3.5	

Puffinus griseus
Larger than P. diatomicus

Br. dist	7.5	53%
Br sh	6.3	
Depth	3.5	

AL

P. conradi descrip.

Brach. impression deep + circular
Ectepi cond process broad base
Entepi cond not markedly protruded anteriorly
Ext condyle narrow + slanting medially
Int. condyle very slightly distal to ext.
(nearly on same line)
Pronator teres attach long, facing almost directly palmad.
Brach imp. prox edge is almost at level of prox edge of ectepi proc. (a trifle but more distal)
Ectepi proc. with slight convex prox contour, concave distal contour as it rounds to shaft.
Both condyles seem small.
Brach imp. abuts against pronator teres attach. at lower left edge (when palmar side faces you) then goes up + ext'ly. Lower it edge is about 2.3 mm above ext cond. tip
Upper it edge 3 mm from sh. edge above ectepi proc.
Hardly bone with palmar surface facing you, entepi cond. just barely visible (anconal part of it) it + int. condyle
Dist. contour of int. condyle + entepi condyle notched about midway (slightly means palmarly always)
Ectepi proc. is not clearly set off shaft. hard to say where it begins, exc. distally.

P. concadi

9.2 br. dist. condyles (palmad)
13.6 diag. br. dist end from ant epi cond postly + int'ly to ext condyle
10.4 Depth int'ly dist from condyle through epi condyle (anconad)
8.3 Depth palmar - anconad wi ⊄ calipers flat anconally tangent anconal bulge of ext cond. + ant epicond
1 X 12.5' Dist from dist ext cond. to prox edge of ect ext cond prox. where it contacts shaft
3 X 6.7 Base of ext epi cond, prox. (distance along its contact with shaft)
2 X 5.3 appros "bt" ext epi proc. from shaft to tip:
9.1 Distance int. cond (distal edge) to tip of pronator teres attach,
7.2 Distance int. side pronator teres attach (palmad) to ant epicond, (anconally)
11.3 Distance to top of trach. impression from intercondylar trough distally,
7 7.3 Ht ext cond (diag.)
3.7 " int cond.
69,820 { X 5.0 Br sh above ect epi proc
7.8 depth sh same place
69,920 { 5.1 Br sh near mid.
7.3 depth sh same place
4.6 Ht pronat teres attach
3.5' Br, ext cond. dist.
5.2 " " " near tip
5 3.7 gr. br. ext cond.
8.3 depth ext cond. (palmar - anconad)

Puffinus with flatness of shaft like
P. conradi — continued from p. 1

P. griseus — resembles conradi, shaft similar, but more slender, ext. cond. broader distally, Ectepi cond. prox. more attenuated & higher

P. nativitatis flatter shaft, smaller all over, ectepi prox. turns up

P. puffinus — smaller, flatter shaft elongate, ectepi turns up

P. l'herminieri still smaller — ectepi turns up
Bermuda

P. (brevicaudatus?) New Zealand, quite similar to conradi but a bit smaller

* P. creatopus — not as flat but should be compared, Has broad bars ectepi prox. Ext cond is broader & more ext. Broad imp shallow slightly higher on shaft

Subgenus Ardenna

griseus ectepi prox convex dist. contour base not so high as front Ext cond. broader more oval bradimp

tenuirostris ectep. straighter prox border more definite take off from shaft bradimp. higher above prox. Ext cond. broader. More flat shaft

Examined
Puffinus conradi Cart & Typical at B.M. 2.6.63
U.S.N.M.

Not Subulcatus Brewster shaft in fossil is laterally flattened. Not Puffinus diomedea for same reason. Ditto P. borealis. Ditto P. creatopus

+ P. cuneatus (less marked in creatopus Reverse has segmentally
Pterodroma ditto (very small cooki compared ext cond. more vertically placed
also Pterodroma nociferalis

Puffinus from Subulcatus also in tarsi & imp. lower (Subulcatus imp gives obtuse leaf yet epi pro.
High tarsi & imp also in Procellaria which is
not flat either.
+ Procellaria
High tarsi & imp. in Puffinus creatopus tho less high than Procellaria et al

Puffinus that are flat laterally
P. reinholdi (even flatter than fossil
broad ext cond + smaller ext epi attenuated
P gavia also flatter than fossil, + smaller
Cut exactly like reinholdi

* P. major gravis flatness about
Subgenus Puffinus same as fossil but ext epi
condyle projects more medially
+ ext epi and process more
attenuated. (Fossil has
wider base
proximo-distally)
Olerani forca deeper than
fossil

P. tenuirostris somewhat flatter than fossil
but worth comparing
(over)

Miocene shearwaters from checklist fossil birds (1)

× Puffinus inceptor Wetmore, 1930

Shaktoolik Hill Mid Mio (Temblor) Bakersfield

✓ Proc. Calif. Acad. Sci., ser. 4, 19(8): 84 figs 1-3

Distal humerus (right) Larger than P. diatomeus
smaller than P. conradi

Br. dist. 12.2 mm.
Br. sh. 5.9 mm
Ht epicond. proc. 4.6 mm.
Br. " " base 4.6 mm

Proportions as in P. tenuirostris
but smaller & ectepicond. proc more slender.

× Puffinus conradi Marsh, 1870

Calvert formation, Mid Miocene Maryland

Amer. Jour. Sci., ser 2, 49: 212 Type humerus + ulna

✓ Wetmore, 1926 Auk 43: 463-464 Wetmore removed ulna to Puffinus sp. ("decidedly smaller")

(Acad sci (Phil?) #13360)

Dist humerus, 1 Br. dist. 13.4 mm.
Br. sh (appx) 7.1 mm.

Marsh compared with P. cinereus
Wetmore says closest to P. gravis
sh same size as P. gravis
ectepi proc. shorter & broader
base than P. gravis. Other minor diffs.
Wet. says Mio. ancestor of gravis

(2)

Miocene Shearwaters — from fossil Checklist

Puffinus diatomicus Miller 1925

a. Lompoc Mid Mio (Temblor)

Carn. Inst. Wash. Publ 349; 111-113, pls 1, 2, 7a

Orr, Robt. T. 1940 Auk, 57:105 (a 6th specimen)

b. San Pedro

Miller, 1935, Pub. Univ. Calif. La. Biol. Sci. 1:74

Type; Nearly complete skeleton on slab
Cotype Left wing on slab
Referred; 2 nearly complete skeletons on slab
1 fragment

Closest relationship to P. dispristhomelas but slightly larger leg

Measurements ← Additional → from Mt Pleasant all together from P. diatomicus Mill

	from Mt Pleasant P. diatomicus	P. dispristhomelas (77.5-85.1)	Type	Cotype	#2	#3	Calif. dead spec.	all together from P. diatomicus Mill
humerus length	86		80	87	82	—		77.4-87.0
" width	78 (90% hum)		75 (93% hum)	79 (92% hum)	74 (92% hum)		72	
" Capmus	45 (57% width)		—	46 (61% width)	45 (59% width)			
1st phal,	21		—	21	21			
2nd "				21				
Tibia bt. art,	65 (83% width)		73 (97% width)	72 (91% width)				
brain HH	(42.8-47.2)							
Tarsus	41 (69% tib 57% width)		—		53 (69% width)		48 (66% width)	51.9-54.6 (brain HH)
femur	31 (47% tib)		30 (41% tib)	—	33			
Cora. axial border	27		27	27	—	22		
" -costal "	34					32		
skull length	86		90					
scapus,	42		—	48				

Miocene Fearwadus

× Puffinus sp.

Miocene, Chesapeake Bay cliffs, Calvert Co., Md.

Marsh 1870, Amer. Jour. Sci. ser. 2, 49:213

Rt. ulna "smaller than P. conradi"

× Wetmore, 1926, Auk, 43:462

× Wetmore 1938 Proc. U.S. Nat. Mus. 85(3030):22

Dist ½ ulna Acad Nat Sci # 13,360 (same sp. as. conradi)
1 assoc'd with P. conradi
Smaller than P. conradi (about as P. puffinus)
so a dif. species probably. No meas. given

× Dist. humerus (USNM 15160)
Larger than P. conradi ("distinctly larger")
Differs from P. diomedea borealis + due to its poor condition (very worn) cannot be distinguished therefrom.
Br. dist. end. 14.9, Br. sh. 6.7 mm.

× Puffinus, sp.

Miocene (Temblor) Bakersfield

Wetmore, 1930, Proc. Calif. Acad Sci. 4ser., 19:89.

Part of distal humerus

Size of P. creatopus
Cut heavier shaft

Similar to P. conradi of Maryland – a bit smaller

Br. dist. 12.8 mm. — P. conradi 13.4
Br. sh. 6.9 mm. — " " 7.1

* Skull held so Foramen is at RL to bar calipers (T is 1" horizontal)

Shearwater measurements

	← Puffinus griseus					P. cornata (1) Fossil		P. carneipes (2) Fossil		P. creatopus		P. gravis	P. mitchelli Fossil	P. pacifica Fossil	P. pacifica Fossil	P. diatoma Fossil
	64	577	50	299	49	~~Hist~~	163A	3.9	Toxid P. calthrops Hatch F7308	Rec. P.p. carneipes	Rec. P. terminitus #1118	698	577	Rec. P.p. opisthomelas	Rec. P. gravis	16.25 17500	16.25 44658	6688 18140	
Length humerus	107.0	108.8	104.4	108.1	107.1	—		87.2		100.6	100.4	113.5	108.7	77.4-85.0	118.4	98.3	80.3	82.2	75-84
Dist. w. Bn. cond.	9.4	9.2	9.5	9.3	9.5	9.2			type 7.1 rel. 60-62	8.7	9.2	10.6	8.3	7.1-7.6	10.8	(8.5-9.1) 8.15	7.2	7.3	(7.1-7.5) 7.1
Depth sh	7.3	7.1	7.5	7.4	7.0	7.8			6.2	5.1	6.3	6.0	7.1	5.0-6.0	6.4	6.5-7.0 6.5	—		6.1
Bn sh	3.8	3.6	4.0	3.8	3.5	4.0			31-33 3.7	3.7	3.6	4.5	3.4	2.9-3.3	4.5	3.2-4.3 4.3			
Hist. ectepicond. from cond. upr.	10.7	11.9	10.0	12.5	12.2	12.5			9.5	9.8	10.4	11.4		9.1-10.0	11.0	(10.9-11.5) 11.5	—	10.0	11.5-12.0
Length coracoid	32.3	32.9	32.8	34.9	33.5							33.5			31.4				
Length femur Ext	38.1	39.0	38.0	39.1	38.5							41.6			40.4				
" " Int	36.2	37.4	36.2	37.2	36.9							40.0			38.5				
Length ulna Total to axis X	99.3	102.6	96.9	101.3	101.1							111.6 X			116.9 X				
Length Tibia X	84.2	86.1	82.6	84.7	84.0							80.4 X			86.3 X				
Total length tib. with crew tip	101.9	105.1	101.1	104.2	103.4							93.6			100.5				
Length radius	96.2	99.4	93.3	97.4	97.2							107.8			113.8				
Length carpo— Ext	—	56.3	53.0	56.8	56.1							56.7			60.3				
Length carpo— Int	—	55.7	52.8	55.6	55.5							55.9			59.6				
Length tarso— center X		56.5 X	56.5 X	58.3	57.8							54.8			57.8				
" Int		54.7	53.5	54.8	54.1							51.4			53.9				
" Ext		56.2	54.9	56.2	55.3							52.4			55.7				
Total Length Sacr. X	93.7 91.0 90.7	90.2	85.0	98.2 with sheath	93.5	at 7.77 7.1		93.0	95.1	93.8		93.2			99.1				
Bn/depth sh Sum, 52%		50	53	51	50							74%			70%				

✓ = within range of P. spithamelas

Ratios	next closest specimen	P. grisea				min	max	Dif.		P. crotaphoides	P. grisea
	64	577	50	299	49						
Humerus to skull	118– [114]	120	122	110+	114	114?	122	8%	humerus rel. longer in crotaphoides	122	119.5
[within] Tibia & ulna	84.9	83.9	85.4	83.6	83.0	✓ 83	85.4 ✓	2.4		72	73.7
Tarsus & Hum.	—	53.7	54.2	53.9	54.0	✓ 53.7	✓ 54.2	0.5			
Femur & Hum.											
Hum & ulna	92.7	94.5	92.4	93.7	94.4	92.7	94.4	1.7	hum. rel. longer in grisea		
Tarsus & fib		67.8	68.3+	68.7	68.7	67.8	68.7	.9	tarsus rel. shorter than in spithamelas		
carpus & ulna		54.3	54.6	54.9	55.4	54.3	55.4	1.1	carpus rel. shorter than in spithamelas		
Coracoid - humerus	30.1	30.2	30.7	32.2	32.2	30.1	– 32.2	1.1			

Topanga Rd. specimen from Mike Jennings ("1")

Agrees with P. diatomicus as contrasted with P. gristlas

Humerus slightly shorter than skull

Tibia ~~appr. matched~~ over 90% lengthy humerus (only 78-79 in gristlas)

(Ht ectep. proc. 13.7%)

Differs from P. diatomicus

Coracoid longer (as in gristlas) rel. to hum. = 39% only 32-33% in diat.

Actual size of all elements (except cora.) slightly below min. of P. diat.

NOT Published as of 1974

Who? → 30 20 13th St. Boulder, Colo. % Laurence Cradle

Tejon Quet Canyon specimen (Sta B, Mus) ("4")

Wing bones only so no ratios to skull or leg bones possible

In size humerus is 3 mm longer than max + 1 mm + deeper shaft (3.5% longer)

" " ulna is 6.7 " " than max 8.5% longer

Ratio ulna to humerus is 98.3% (P. diat. 92.6-95.7)

Ratio carpus to ulna is 53.6% (P. diat. 58.2, 57, 57.7) depth 57.2-60.7

Ht ectepi cond. proc. from dist end 10? (P. diat. 10.5?) P. gristlis 9.1-10.0

11.5% 12.8%? 11.7%

Dept sh. suggests P. mitchelli just described but ectepi cond. proc seems more produced

NOT Published as of 1974

Sepulveda specimen Mike Gee of P. diatomicus

Published 1962

No humerus

Ulna is 74.5 - within range of P. diat.

Tibia is 70.3 " " " " "

Tarsus is 51.2 " " " " "

Ratio tarsus to ulna is 68.7% (66.3-70.3 P. diat.)

Ventura Co. specimen

Ratio tarsus to ulna 69.0% = P. diat

Dept sh. hum. 5.6 as in P. diat.

Ratio ulna to stuff 7.1 (of P. diat.) (91-100 in gristlis)

Tibia 63.8 (shorter than any P. diat.)

Ht cnem crest 12.0 = 18.8% (P. diat is 23%) also crest is straight

Ratio ht. to ulna 95% (P. diat 88-97 (type is 97.4)

Not published as of 1974

~~Tibia shorter than P. diat~~

" " "

3.25.76

P. kanakoffi

2516 length 66.9 to deltoid
sh Br./dist. 3.6 × 5.5 mid 65.5
trach imp. 3.2 × 4.0
dias ht

2514 Br. depth sh. 3.7 × 6.6 abme brachial imp 56.7% ✓

2444 { 3.3 × 5.7 Br. depth shoulder 58.% ✓
3.2 × 5.0 " " mid 64.0%

2448 { 3.5 × 5.5 " " " 63.2%
3.5 × 6.0 " " abme brachial 59.3% ✓

42652 { 3.9 × 5.9 " " mid 66.2%
loc 6906 { 3.8 × 6.1 " " abme brachial 61.7% ✓

9.3 ht ectepi proces ± 2447
7.8 Br. dist "
~~2716~~ 2114 A — length 65.5 to deltoid
3.2 × 5.4 Br. depth sh mid.
7.7 " "
8.7 ht ectepi

dist 7.7 ± 42652
ectepi 9.5

7.6 Br. dist 2114
9.5 ectepi abme dist
3.5 × 6.6 Br. depth sh abme brachial
3.5 × 5.8 " " mid

kanakoffi very similar
but art. facet smaller?
trach. imp. longer diagonally

7.6.66

Puffinus from Capistrano fm. Cap. Beach.

Leyth skull 88+02 ✓
" lower jaw 73.4 ✓
" beak (?) 43.2 ✓
" carpometa 39.0 ✓
" P1 D2 19.7 ✓
" P2 D2 19.5 ✓
Total leyth hand 76.6 ✓
Leyth ? radius 67.3 ?
" ? ulna 74.4 ? ✓
" foot to longest 43.5 ✓

California Miocene Puffinus

Middle Miocene Shahtoth Fm

P. incepta Wetmore – dist end humerus CAST avail
" " " " " "
P. priscus Miller – " " " " " "
P. mitchelli Miller " " " " " "

late Miocene

P. diatomicus Miller skeletal impressions CASTS

P. calhouni Howard dist end right humerus TYPE
Loc 1945 dist br. 7.1, ht ectepicondylar Proc. 9.3
dist depth 8.0, shaft 3.0 x 6.0
referred dist left humerus 17539
prox right ulna 17530
prox 2/3 tarsometa 17582

Puffinus barnesi Howard dist end humerus TYPE
Loc, 6904 length dist end to distal top deltoid crest 67.0
estimated gr. length 80
br. dist condyles 7.7, depth int., side dist end 8.4
ht ect epi cond proc. 9.5. shaft m. dist end 3.5 x 7.7
shaft middle 3.9 x 5.9
referred ulna (manus olecranon)
length to intercotylar ridge 70.8
prox br. 6.5, dist br. (ap.) 6.4,
dist depth (ext) 5.3, shaft mid. 3.5 x 5.3

Hulmanus hammeri Howard 1968 Prox carpometacarpus TYPE
Loc 1945
larger than modern H. glacialis
- Prox depth internasal x typ M 1, 13.1 mm
- length process M 1 8.8 mm, br. trochlea 5.5 mm
- Referred humerus (dist frag) ht ectepicond 12.8

Very late Miocene or Early Pliocene

Puffinus stedfordi Howard 1971, Loc 1 do Prox Tarsometa TYPE
prox br. 6.8, least br. sh 3.3,

Puffinus felthami Howard 1949 Dist humerus TYPE
corona del mar

San Diego Fm

Late Pliocene

Puffinus kanahoensis 1949 type tarsometa

Miocene Puffins

P. arvernensis Milne Edwards 1871 p. 572 from France
Aquitanian
Lowermost Mio.
and Shufeldt 1896 Proc. Acad Nat Sci Phila p. 510

Type left tarsometatarsus
length 41.7, prox b. 7.2, dist b. 7.4, shaft 3.3 x 3.5 mid-ext

P. micranlax Brodkorb 1963 Quart. Jour Fla. Acad Sci. vol. 2 p. ?
Lowermost Mio Hawthorne fm.
Type distal end left humerus from Gainesville Florida
br. dist. condyles 5.4 mm.

P. aquitanicus (Milne-Edwards 1874) France
Type dist end humerus (108 mm ??)
Mid Mio Burdigalian

P. antiquus (Milne-Edwards) 1874 larger than P. cafensis France
Mid Mio Burdigalian
Type prox end humerus (same as aquitanicus)

P. conradi Marsh 1870 Amer. Jour Sci ser 2 vol. 49 no 146 p. 212
Mid Miocene Calvert fm, Md.
Type distal end left humerus Acad Nat Sc. Phila catalogue 43; 463
restudied by Shufeldt 1915 + Wetmore 1926 Auk

Shark tooth material only

Newer material adds 28 + 0 -
Coracoid, ulna, tibia, cranium ? tarsus
II HHI I I I

sacrum complete humerus prox humerus distal humerus
I III IIII HH IIII

Recorded material above 16?
Distal humerus known in 10 - 12
Proximal humerus " " 3 or 5
Tarsometatarsus " " 2
ulna
carpometa only in Fulmarus

Check prox tarsus 1945/17554 and 1945/17565 1557/16463, 16464 bro, 13.7 + 12.7
Note prox b. % tarsus 3801 from MV 46 w agrees w/ in Missoula = 17.5 mm
Check this to the two Shanktoolth tarsi also.

Check "Missoula" 1945/17556 dist. humerus with humeri from S.T Hill small humeri all now in my office drawer

Nows bassaris prox tarsus 14.45
☆ turn 17565 from Lee. 1945 says short about as in bassaris but diff. greater than bassaris

Note length of humerus of specimen of sulid at "cultural Center" in Mission Valley is over 225 mm (250?) sh. br 14.4 (4 inches from dist end)

Coracoid length to internal tip sternal end 69.5
(This is greater than the coracoid from Shanktoolth Hill 6-C-5 (57.4 mm))

Check 1982 assoc. Sulid material to Missoula media for size and anything else applicable. See measr. in "Miocene Sulidae" file. See UP for Oso Dam material also

Check upper Oso Dam Lee 4547 radius + ulna 120438 to small specimens in 1982 coll S# Hill + also to S. foliti because it is noted that the radius looks more like Sula from Mono. Unfortunately none is no coracoid or tarsus in S. foliti. These elements from Oso Dam fit S. willetti, but might also agree with S. foliti

for 1966 paper but good reference for subsequent use

LITERATURE CITED

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Howard, Hildegarde. Miocene sulids of southern California.
1958 Los Angeles County Mus. Contrib. Sci., 25:1-15

Miller, Loye. Birds from the Miocene of Sharktooth Hill, California.
1961 Condor ~~64:471-472~~ 63:399-402.
1962 A new albatross from the Miocene of California
Condor 64:471-472.

Mitchell, Edward. History of research at Sharktooth Hill, Kern County, California. Specl. Publ. Kern County Historical Soc. and County of Kern through its Museum.
1965. vi + 45 pp.

Wetmore, Alexander. Fossil bird remains from the Temblor Formation near Bakersfield, California. Proc. California Acad. Sci., ser. 4, 19:85-93.

Spread 850 for N. area

After 1965 : ADD

Howard H. 1966. Additional avian records from the Miocene of Sharktooth Hill, California. Contrib. Sci. No. 114: 11 pp.

Walker, S. 1976.

Subsequent to Mitchell 1965 report

Museum collecting when?
Kinkland collecting when?
Others?

from Mitchell 1965 pp 19-20

1st bird bones collected 1924 by party headed by Charles Morrice. Basis of Wetmore 1930. Pub.
D. B. Stevens found cranium of M. vagabundus in 1929 about 7 miles NW of type loc. of M. vagabundus & this was assigned by Compton 1936 to M. vagabundus & same horizon (Mount 7 miles N.W. of type loc.)
Jos. Arnett & Mitchell made the collection
L. Miller visited in 1961 by Miller
Miller's 1962 descript of D. Calif based on bone called by Arnett

Loc 3162 Kuhland coll 1968
9649 Dist. ulna Monus sp. (depth 9.5)

Loc 3230 ?

Loc 3205
Tylopoda Camelus hemiauchenia
unnumbered, Dromedary dist. Tibia gr. ant-p. 18.4, gr. depth 18.9

Loc 3208
5-2661 Small dist. frag. (unc.) humerus Coll 1973 By Tracy Storer

Key to Shearwater humeri - distally

Shaft above distal end

A Breadth more than 60% of depth

Rec. P. gravis, P. creatopus, P. pacificus
for. P. incautus, P. conradi

B Breadth 55% approx of depth

Rec P. griseus, P. opisthomelas

for P. felthami, P. mitchelli, P. pacificus, P. calhouni, P. kanakoffi

(1) Internal condyle projecting prominently on anconal side

Rec. P. griseus

for.

(2) Internal condyle less projecting anconally

Rec. P. opisthomelas 120, 107 Type P. diat.?

for P. pacificus 124, P. felthami 117

P. mitchelli 115, P. calhouni 114, P. kanakoffi 116,

(3) Shaft (initially) narrowing abruptly above ectepicondylar process

Ratio depth at top of process through condyle / depth shaft above

20% greater P. kanakoffi 20%

15% greater P. felthami 17%, P. calhouni 17%,

30% P. mitchelli 32% ref.
28% type (inc. anconal contour)

P. pacificus 27 ref. (Type inc.)

Dept. int. cond / dept ext side sh. above ectepicondylar process (reverse ratio)

51% P. felthami
46% P. mitchelli
48% P. pacificus (ref 52% Lag. H.)
49% P. calhouni
52% P. kanakoffi

Ht ectepi / br. across condyles

124
125 } P. kanakoffi
126
135 Type P. calhouni
135 Ref
132 Type
130 Ref P. pacificus
132 P. felthami
132 }
130 } P. mitchelli

Ht artic surf. / br cond.

95.7
94.5 P. calhouni

90.5 P. pacificus sub
92 P. pacificus? Lag. H.

SHEARWATERS -- MIOCENE

Known from California
Puffinus inceptor -- Sharktooth Hill * P. gravis, P. mitchelli
Puffinus sp. " "
Both rather large
Puffinus diatomicus -- Lompoc and San Pedro, total 8 specimens

Now available -- ~~three~~ four additional specimens from
① Tepusquet Canyon, Sta. Barbara County (WINGS ONLY) SBMNH #319
② Balcom Canyon, Ventura County (SKULL, LEG, PART of WING) LACM #2706
③ Topanga Canyon Rd., Los Angeles Co. (ALL ELEMENTS) Mike Jennings specimen
④ Sepulveda LACM 2705 Published as P. dictyrhinus 1962(?) not a Puffinus

With the exception of the ~~two~~ specimens from Sharktooth Hill all are impressions in slabs of shale (some bone adhering)

Tepusquet Canyon specimen, wing bones are longer than those on any specimen of diatomicus previously recorded, but not excessively so. Ulna and wing phalanx, however, longer in proportion.

Ventura Co. specimen is consistently smaller throughout

Topanga Road specimen is smaller than diatomicus but not so small as Ventura. It seems, however to have a longer coracoid. The length of tarsus can only be estimated and the fact that the estimate makes the element relatively smaller than diatomicus cannot be taken too seriously. The longer coracoicd may be important.

Conclusions: That though these specimens represent many parts of the skeleton (whereas many avian fossils are based on a fragment of a single bone) it would not be safe to consider the differences that appear to distinguish them from diatomicus sufficient to erect aeparate species.

Diatomicus differs from opisthomelas (Black-vented Shearwater) in relatively shorter wings and longer legs.

If all these specimens are assigned to diatomicus the range is as follows:

	former min.	and max	new min.	~~and~~	max.	min max opisth.
skull	79.6	90	77			78.3 - 82.0
humerus	75.0	84	73.8 ✓		86.8	77.4 - 85.0
ulna	71.0	79	66.9		84.4	70.6 - 78.6
cappometacarpus	41	46	40.3		47.2	46.5 - 46.5
femur	30	33	28.7			30.1 - 33.8
tibiotarsus	68.8	73	64.0			60.5 - 64.2
tarsometatarsus	50	54	46.0			42.9 - 42.4
coracoid	22	27			29.4* ✓	26.3 - 29.2

*on an otherwise small skeleton

✓ Topanga specimen other "mins." from Balcom Canyon (2) (no humerus from Balcom)

* With the addition of P. gravis + P. mitchelli from Sharktooth Hill, These sp. must be taken into consideration now in identifying the Tepusquet + Topanga Canyon specimens.

Characteristics of P. diatomicus

Humerus

High Eclepicondylar process very high above distal condyle (13 – 14+ mm.) considerable space between distal margin & radial (= external) condyle

Get meas. Deltoid crest rel. long (?) apex lower than on some other species

Depth of shaft rel. slender (like P. gracilis.)
6.2 – 7.2% of length

Tibiotarsus

Ht cremial crest 13 – 14.7 sp. mm.
narrow " "

Proportions

Skull longer than humerus (humerus longer in ale (Recent)
Skull to humerus 108.6% skull to ulna 116.2%
Tarsus rel. long 63 – 66% of humerus; 66 – 69% of ulna
72 – 77% of tibia (not including cremial crest)
53 – 57 (to hum) in diatomicus
53 – 54 " " " gracilis
Ulna 92 – 95% of humerus { (P. diatomicus 90 – 92.6)
(94.6% type) P. gracilis 92 – 93
91.2 cotypicant)
? Coracoid 32 – 34% of humerus 33 – 35 diatomicus
30 – 32 gracilis
(39.9% in juvenile specimen
32.9% cotypicant
36.2% type

Torrey Canyon Pit	specimen	pratus	mitchelli	depth. sinus
length eclepi proc	4.2	3.7	3.3+?	
base " "	3.6 – 3.9	3.2	5.1	
ht " "	9.6	10.2	10.5	9.1 – 10.0
length deltoid & head	19.3			
" " to ext tub.	17.4			
total length humerus	73.8			
depth shaft	6.1	6.4 (6.3)	6.7 (7.0)	5.0 – 6.0
ht proc / depth sh	63.5%	62.5% (61.6)	64.0 (66.6)	57.1, 58.7, 60

Jennings specimen has higher longer cranial crest on shorter

tibiotarsus	type	2703 Lacm
length tibio	74.2	68.7?
ht crest	14.5	17.0
	19.6%	24.7%

humerus shorter with stubbier ectepicondylar process less raised above distal end (Not turned up)

	type	2703	Lacm specs.	P. fuscus
a length num.	79.4	73.8	78.4	
ht ectepi	11.6	9.6	11.1	9.8
ba	14.6%	13.0%	14.2%	
length proc		3.7		3.7
br at base		3.5		3.2

Relative length skull + humerus 105.5% (type 108.6%)
" " " " " ulna 111.0 (" 116.2)

#2706 has short cranial crest
middle toe longer than tarsus
upturned ectepicondylar process
} as in type but all bones smaller

skull
78.2 × 66.7 (ulna) = 116%

(lew. mandible 22.3
type 25.0)

(cont
5

Teepungent spec.
humn. ectepi prox. shaft ant 4.6 mm
" " is 11 mm to bone condyle
11 has ~~short~~ deltoid crest compared
with felthami 13.2 from head
to center of crest, 22. from head
to distal end crest
10.3 mm. from head to distal edge
of median crest
6.8 ~~depth~~ shaft

6.2 felthami dept ant-side dist. end

(3) (4.2 at base prox-dist mead)

(1) from shaft to tub
4.4 T ~~9.8~~ from (2) prox edge to dist. condyle
ectepi of Woodland Hills
74 lgth humn. Ceramic 29.5 or more
turns up slightly

Ventura bird
(2) (1) (3)
10.2, 4.4, 3.4 ectepi of Ventura humn.
br. shr. line br. 3.5 humn shr
depth 5.6 varies (5.4-5.7)

ulna 67

$$\begin{array}{r} 1.4 \\ 11.0\overline{)15.4} \\ 110 \\ \hline 440 \end{array} \qquad \begin{array}{r} .71 \\ 154\overline{)110.0} \\ 1078 \\ \hline 220 \end{array}$$

$14\overline{)11.0}$

$\frac{x}{x} \quad \frac{11}{} = 15.4$

$15.4x = 11$

Specimen no. L.A.Co.Mus. 2703 collected in 1960 by Mike Jennings on Old Topanga Canyon Road, near Ventura Blvd. in the San Fernando Valley, Los Angeles County.

Material available: the main skeletal elements are represented (some incompletely) on several obverse and reverse slabs of diatomaceous shale.

Description:

The skull, humerus, ulna and carpometacarpus are all slightly shorter than the minimum so far recorded for P. diatomicus; the femur falls within the size range of the latter species; the incomplete tibiotarsus and tarsometatarsus are incomplete but their lengths can be estimated by the way in which they lie in the matrix, the former being approximately equal to the minimum for P. diatomicus, the latter very much shorter; the coracoid, on the other hand is longer

~~Detailed two elements characters of this skeleton distinguish it from P. diatomicus, namely and humerus with deeper shaft, heavier ectepicondylar process set nearer to distal end; tibiotarsus with higher cnemial crest.~~

Although details of skeletal elements are difficult to discern in the fossils preserved in diatomaceous shale, the following characters can be compared and serve to distinguish the San Fernando Valley specimen from P. diatomicus: humerus, with shaft deeper, ectepicondylar process heavier and set nearer to distal end, tibiotarsus with higher cnemial crest, ~~deltoid crest shorter.~~

Much more difficult is a comparison with those species of Puffinus which are known only from isolated bones. especially those in which only a fragment of an element is represented and the diagnosis depends on very detailed characters. On size alone it appears safe to rule out the two Pliocene species, P. kanakoffi and P. felthami; The former had a longer, more slender humerus and seemingly a longer tarsometatarsus; the latter appears to have been a much larger bird throughout its skeleton, both humerus and tarsometatarsus being of greater size than the fossil now under consideration.

P. inceptor
In P. conradi,/P. priscus and P. mitchelli, only the distal portion of humerus is available.

Pub figures slightly different

Good

"EL TORO"
now = LACM Loc. 1945
Leisure mines

5.25.66

Tuffinus

Humerus	Right El Toro 1	Right El Toro 2	Left El Toro 3	Right El Toro 4	Left El Toro 5		San Diego → P. kamabitti → Left 2116	Right 2114	Right 2120	Left 2160	P. diatomicus type ulnar cast	P. diat. lacm spec. ulnar cast	P. pelagicus pub. P. pelagicus pelagicus	P. pelagicus type	P. pelagicus shaft 1962 (?) enclosure	P. pelagicus refid. skeletal	Jim Bishop shaft dist. section	P. mitchelli cast type	Bishop complete humerus
a Prox. dist. condyle	7.5	7.1	7.3+	—	—		7.5–	7.5	7.4	7.6	7.1	—	8.5	7.3	-	7.5(?)			7.7
b Depth int. ly	8.9	8.1	8.2	—	—		8.5	8.8	8.5	—	7.7	—	10.1	8+					9.1
c " ext. ly	6.8	6.3	6.1	—	—		6.8	6.4	6.1	6.4	—	—		7.1					6.8
d ext. cond. diag. to tip	7.5	6.8	7.1	—	—		7.3	7.1	6.9	7.4	—	—		7.2					7.5
Shaft dist. gall-e Nt. to p. intercar	6.3	6.5	6.1?	—	—		7.0.	7.3?	7.0	7.0	5.2	—		6.4					6.5
* Rotor b Ht. ext. tip. prox.	(8.8?)	9.4?	9.2?	9.0? 8.9?	—		9.5	9.7	9.1	9.4	12.0	10.7? 11.3	11.0	9.7? 10.0		10.1			10.0
Dist. Br. ant. artery tip. cat. d	3.2/1.8	3.2/2.3	3.3/1.9	?/2	3.8/2.1		3.8/2.2	4.2/1.7	3.1/1.7	3.3/1.9	3.3/2.3	—		3/2	pub. 54% 6.3/3.5			68% pub. 7.0/4.2	3.4/1.6
Depth/Br. Shaft e	—	6/3 56%	5.9/3.3 56%	5.9/3.3 56%	6.1/3.2 52.5%		5.1 90 5.2/2.8	5.5/3.0 54%	5.2/3.0 52.6%	6.3/3.3 52.5%	6.8/?	6.1/?	55.9% 6.9/3.8	51.5 6.2/3.2	6.0/3.1 52%	—	58.5% 6.5/3.8	54% 7.2/3.9 54.9%	54% 6.5/3.5
Depth/Br. brach. in. i	—	4/3	4.3/3.3	4.2/3.0	4.3/2.9		4.4?/3.2	5.4/2.8	4.2/2.7	—	4.0?/3.3	—		4.6/3.0					3.9/2.7
% ea	89.3	88.8	86.7	—	—		93.4	97.5	91.2	92.2	73.2	—		89.6					
% fa	118%	135%	124.6%				126.5%	129.2%	122%	120.2	169%			137.7%					
% depth h/a	—	91.5	81.1	—	—		73.4	73.4	86.5	82.8	95.8			84.9					
Tarsus	← prox. (1) Right	(2) Right	(3) Left	(4)	(5)	3 shafts	Right #2572	Right 2120	Left 2127 TYPE		Lomita								
Gr. prox.	—	7.1	7.1				6.45	7.1	6.5+		6.8	—	7.5						
Gr. sh below prox	3.3	3.6	3.3			2.6/2.9/2.9	3.1	3.0	3.1		3.4	—	3.3 2.8 pub						
Depth sh. int	3.1	2.9	2.7			3.5 3.0/3.3/3.2	2.9	3.0	3.1			3.4	3.2						
" " ext	4.4	4.5	4.3		4.6?	5.8 4.1/4.4/2.4	3.7	3.5	3.9			4.7	4.3 3.9 pub.						
Prox. end, ext depth/Sh. hypo.	5.97	6.1	6.2		—		5.8	6.2	5.7			5.45							
Br. dist. condyles				6.9	—		6.3	—	6.2		6.25	—							
" " sh				3.2	2.7		2.65	2.7	2.6		3.2	—							
											Right tarsus 54.0	51+							

Oct. 25, 1961

Shell layout meas is from tip to tip, tips of calipers to each tip (smaller calipers are ⊥ at RL to tomium

meas. are min. to max. possible variation depending upon placement on imbedded specimen

✓ = element in type
x = " in illus spec.
+ = " in cotype

	P. opisthomus #554 cf (to fossil) Tibia shorter, humerus longer, femur equal, ulna visibly longer, coracoid equal?, carpus longer, shell equal	#554 cf Tibia longer, femur longer, tarsus equal, ulna longer, manus, carpus longer	#554 cf ulna equal, carpus equal, tarsus shorter, tibia shorter, shell equal?	#554 cf humerus equal, ulna shorter, carpus about equal, tarsus shorter	P. diat meas, Rowper A679
	Ventura 2 spec	Sepulveda 3 spec	P. parvus	P. mitchelli 4	Nt carina 25.2
Tibia	68.7 min ✓ / 69.0 max ✓	63.8 ✓	70.3 min ✓	—	70.7
Nt to Crest	16.5 — / 16.9 ✓	12.0 ✓	—	—	13.7 ???
Humerus	73.2 ✓	(Br. ab 3.5)	—	89.2 ✓	78.8 80.0
Depth Shaft	6.1	5.6	6.4	6.7	6.8 → 6.9
Nt ectepic. proc.	9.8 (4.2 tip broken)	10.2 †	—	9.8	5.9
Length ectepic.	4.2	4.4	3.7	3.3 (?)	4.7
" entepic.	3.9 † ✓	NONE	—	4.7 ✓	5.3? [3.2 on 4.2 br. at base]
Coracoid	29.4 - 29.7			31.8?	
Ulna	69.6 ✓	67.3 ✓	64.5 ✓	85.7 ✓	71.7 (69.2 to ext. lip not'l) 73.8
Tarsus	41.5 ✓	46.0 - 47.2 ✓	51.2 ✓	—	51.2
Femur	39.3	29.0 ✓	—	—	30.1
Carpus	40.8 ✓	40.3 ✓	44.3 ✓ / 44.7	46.0 ✓	44.0
Shell	78.5 ✓ / 75.2 ✓	77.7 ✓ / 74.1 ✓	—	—	
" rostrum aut to naso	23.5	23.4?	20.9	—	
Ext meas of tarsus	—	45.4	47.1	—	
Long phalanx	18.8 ✓	—	20.4 ✓	23.2 ✓	
Radius		—	75.2	83.2	69.2 D1 is 20.8
mid phal #1	—	—	19.6	21.9	20.6 (22 is P. 2)
Long pedal toe		46.6	—	—	55.4
Lgth metatarsus	42.0	45.5 47.9	45.4	—	55.0 length 3 phal. 42.0 " mid toe 2nd toe (2 phal. + ungual)
Lgth dominican	68.6 est	71.2	—	—	54.1 " 4th " 4 phal. + ungual
Depth portion at auxy	10.1	8.4 -	9.6		

Balcom Canyon Nov. 8, 1956
Eugene Nicholas + Blanche Nelson
Harry Shetrone

Del gado Drive nr. Sepulveda + Ventura Blvds
Sherman oaks, Calif. loc 1267
June 15, 1961 Michael Bell

Nr. Ventura Blvd. in Old Topanga Rd turnoff
1960(?) from Mike Jennings
Woodland Hills

S. B. Mus. spec. # 319
1956 June 4(?)

Ect epicondylar process is heavier + blunter in
Topanga spec. Dram in questionable
Proc. is longer + turns up a bit more like opisthio
in Ventura spec.

Puffins specimens
from Calif Museum

Table of Measurements (in millimeters) and Proportions (in Percent)

Miocene shearwaters compared with Puffinus opisthomelas

Length elements	P. opisthomelas	P. gurneyi	P. diatomicus	# 2706 from Ventura Co.	# [illegible] from Woodland Hills	# 2705 from Sherman Oaks (Recorded as P. diatomicus)	# 3195 S.B.M.N.H. from Sta Barbara County
Length, skull	73.3–82.5	85.1 [illegible] 98 100.8	77.4 (Stanford cotypes) 79.6–90.0	76.7 ap. –	77.3 ap +	—	—
Length, humerus	77.4–85.0	104.7 105.5	75.0–84.0	—	73.8 —	—	87.2 +
Length, ulna	70.6–78.4	96.9 — 102.6	71.0–79.0	67.3 —	70.0 —	74.5 OK	80.7 +
Length, carpometacarpus	41.5–46.5	53.1 — 56.8	40.5 Stanford cotypes 41.0–46.0	40.3 —	40.8 about OK	44.3 OK	46.0 OK
Length, femur	30.1–33.8	38.0 — 39.1	30.0–33.0	29.0 —	31.3 OK	—	—
Length, tibiotarsus	60.5–66.3	82.6 — 86.1	68.8–73.0	63.8 —	68.7 about OK	70.3 OK	—
Length tarsometatarsus	42.9–47.4	58.3 — 56.5	50.0–54.0	46.5 —	41.5 (?) —	51.2 OK	—
Length, coracoid	26.3–29.2	32.3 34.9	22.0–27.0	—	29.4 +	—	31.8?
Ph. 1				—	18.8 about OK	20.4 OK	23.2 +

Ratios		○ = dry.		Ventura	Woodland Hills	Sherman Oaks	Rancho Capistrano
Humerus to skull	100–109	110 – 122	88.9 94.1	—	95.6 + nearly OK	—	—
Ulna to skull	91.3 101.1		83.3 89.3	87.6 — OK	90.6 OK		—
Ulna to humerus	89.8–92.6	92.4 94.5	92.0–95.6 ucla	—	95.0 about OK	—	98.3 + 98.7 +
Coracoid to humerus	33.3–35.3	30.1 — 32.2	32.1–33.7 (33.2 max)	—	39.7 +	—	36.0?
Tarsometatarsus to humerus	53.2–57.5	53.7 — 54.3	63.2–66.5	—	42.0 + 56.3 —	—	—
Tarsometatarsus to ulna	58.5–63.3		18.8–20 ucla 66.3–70.5	18.8 64.0 slightly less or ucla included	24.3 % + 59.3 —	68.6 slightly less or ucla	—
Tibiotarsus to ulna	83.6–86.7	83 — 85.4	ucla 88.2–97.4	95.0 less or ucla included	97.6 OK	94.3 less or ucla	—
Carpometacarpus to ulna	57.1–60.1	54.3 — 55.4	ucla 56.3 58.3	59.9 slightly more	58.3 OK	59.4 slightly + or ucla	53.6 —
Tarsometatarsus to tibia	69.5–71.7	67.8 — 68.7	ucla = 75.2 San Pedro 72.4–72.1	72.9 OK	60.3 — very	72.8 OK	—
carpus to humerus	51.9–54.9		ucla 53.7–54.9				52.6 —
Ph 1 to carpus			45.6–47.7	—	46.0 OK	46.2 OK	50.1 +
femur to humerus			37.5–40.3 (one 42)		42.4 +		
femur to tib.			41.1–42.3 43.0 (one +)	45.4	45.6		
Depth sh to ht of glen	51 – 60		59.4 – 61.7	56	62.3 % (64)		67 – 70.7

P. gurneyi 67.6
P. mitchelli 63.6
P. [illegible] 68.7

Described as P. feltham

1067 fossil has flat deep shaft of P. grisens
But is shorter, T has shape of ant. side of distal end
T internal condyle = of P. ophistomelas.

1947 meas.

a b c d e

	Length humerus from ant. head to dist. end	Depth shaft middle	Br. of shaft middle	Br across distal articul.	Depth internal cond.	Ratio	Ratio d to a	Ratio b to a	Ratio c to a	Ht ecto-epicondylar process (from dist. articul.)	total length humerus	length femur	Femur: length to depth at same place	Femur: depth at prox. end	Ratio femur: length to max. depth	gr ht gastral	least Depth (quad)	Ratio ht ecto-epicond. to length humerus at dist.
corona length																		
fossil																		
P. ophis 299	71.2	6.9	3.8	8.5	10.0	14.0%	11.9	85.0	9.6	55.1	11.0	est. 88.5–89.2	52–56	2.8	3.9	7.5–6	73–78% about 77%	12	3.2	15.4%
P. grisens 58	83.6	7.3	4.2	9.5	10.8	12.9	11.3	88.0	8.7	57.5	11.4	104.5	56.6	2.9	4.0	8.1	67.7%	10.8	2.5	13.6%
299	87.2	7.5	4.0	9.2	11.2	12.8	10.5	82.3	8.5	53.4			58.0	3.0						
49	84.5	6.9	3.6	9.3	11.4	13.5	10.0	81.5	8.1	52.2			56.8	3.0	4.0					
577	88.0	7.2	3.7	9.0	11.0	12.1	11.0	81.7	8.2	51.4	11.7	108.9	58.6	3.1	4.0	7.9	66.6%	11.0	2.7	13.3%
64	86.0	7.3	3.9	8.8	10.4	12.1	10.2	84.5	8.5	53.5	11.7	107						11.3 11.0	2.6 2.7	13.5%
P. ceratopus 348	90.3	5.8	4.5	9.3	10.4	10.3	10.3			77.5										
698	90.6	5.8	4.5	9.8	10.8	10.7	10.7			77.5										
P. ophistomelas 1373	67.0	5.3	3.3	7.2	8.6	12.8 to intact 12.2 stretch	10.7	83.7	7.9	62.3	10.3	83.2	46.7	2.3	3.2	6.2	69.8%			15.4%
559	67.5	5.8	3.4	7.6	8.8	13.0	11.2	86.3	8.6	58.4	9.8	85.0	45.7	2.4	3.5	6.7	67.7%			14.5%
Pi 541	66.6	5.0	3.2	2.5	8.7	13.3			7.5	64.0	10	85.0	46.1	2.2	3.2	6.7	69.3			15.0
558	65.2	5.3	3.2	7.5	8.6 est.	13.1				60.4	9.8	82.5	44.0	2.2	3.2	6.2	67.4			15.0
556	61.3	5.2	3.3	7.2	8.2 est.	13.4			8.5	63.5	9.1	77.2	42.8	2.3	3.4	6.3	70.0			14.8
553	67.7	5.0	3.3	7.3	8.6 est.	12.7			7.3	66.0	9.3	84.4	45.8	2.2	3.0	6.7	67.7			13.7
543	64.8	5.2	3.4	7.4	8.7	13.4			8.0	65.5	9.6	80.7	44.4	2.2	3.2	6.5	68.5			14.8
544	65.0	5.3	3.2	7.5	8.9 est.	13.7				60.4	9.8	82.0	45.7	2.1	3.1	6.4	70.5			15.0
542	66.7	5.5	3.3	7.4	8.9	13.3				60.0	10.1	84.3	46.7	2.3	3.4	6.0	70.0			15.1
557	65.3	5.2	3.4	7.2	8.7	13.2				65.4	10.0	81.8	45.6	2.3	3.4	6.4	70.0			15.3
555	62.7	5.6	3.2	7.4	9.0 est.	14.4				57.3	10.1	85.0	46.1	2.3	3.3	6.5	68.2			14.9
554	67.0	5.7	3.3	7.5	8.7	12.9				58.0	10.0	84.3	46.2	2.5	3.4	6.3	69.0			14.9
51	66.3	5.3	3.2	7.1	8.5	12.8				60.5	9.7	82.4	47.2	2.2	3.2	6.6	71.2			

1947 mean

Carpinteria – San Diego

Humeri	length	length to deltoid crest	br condyles	br shaft / depth shaft	Femur	length	br prox ep / depth ch	br sh / depth sh	Ratio br to depth hum.	Hume ht ect epi proc.	Ratio ht proc to length to delt.	Depth int cond / ext cond	Rat. tars to hum. (delt.)		Depth int cond		Femur Depth F/B. cond.	br ext. cond. / ht femur	br dist end	br sh / depth sh mid.
2114	21.6	63.2	7.6	3.6 / 3.5	II 2122	45.2	6.7 / 6.3	2.9 / 3.7	63.6	9.2	14.3	9.0 / 6.7	68.4		4.0	# 2124	5.1	5.9 / 4.6	7.1	3.1 / 3.6
					# 2124	47.0	6.7	2.6 / 3.6					71.5							
2120	21.8	65.5	7.3	3.5 / 3.3					66.1	9.7	13.9	8.5 / 6.3	71.4	a						
2160	21.7		8.0	3.5 / 3.2					60.4	10.0		7.9 / 7.0	74.4							
2116	21.5	64.7	7.8	3.0 / 3.2					57.8	10.0	15.4	8.8 / 7.0			3.7	opposite 544	5.3	6.0 / 5.1	7.3	
					1375	pac.cam. 47.4	7.4 / 7.0	3.0 / 3.5							3.6	Rec. 542	5.0	5.8 / 5.0	7.4	3.2 / 3.7
					1358	48.4	7.4 / 7.0	2.9 / 3.2							3.2	# 541	5.0	5.7 / 4.7	7.2	
															3.2	553	4.6	5.4 / 4.9	7.2	
															3.0	543	4.7	5.1 / 4.5	7.0	
opposite 15	27.3	2.1		7.3		54.0	P. did	2.4							3.3	554	5.1	6.0 / 5.0	7.3	
553	31.1	2.3		7.3											3.5	558	4.7	5.4 / 4.7	7.4	
									Carpinteria 40.7 P. chat.						3.7	1373	4.4	5.3 / 4.6	6.7	
															3.2	557	4.8	5.4 / 5.0	7.0	
opp 50	30	2.7		9.0																
577	28.3	2.6		9.2											3.4	connects 1358	4.8	5.5 / 4.9	7.1	
															3.6	1375	3.5	5.7 / 4.8	7.5	
															4.3	creatopus 648	6.2	7.4 / 5.7	9.4	
															4.2	662	5.8	6.4 / 5.0	9.1	
															4.1	349	5.9	6.3 / 5.6	9.4	
															4.1	348	5.9	6.3 / 5.4	9.0	

2115

Specimens of Ruffins diatomicus at UCLA

Va.3 C+ 53'1

1947 meas.

	Length of lateral deflection of Humerus	Total length Humerus	Length femur	Length tibia	Length tibia & art. surface	Ht ectepicondylar process Humerus	Breadth Humerus	Length femur	? Length condyles & intercondylar angle	Ratio femur length to humerus length	Ratio femur & humerus (length of lateral deflection)	Length middle toe (3 phalanges)	Ratio ectepicondylar height humerus to lateral deflection	Length heavy mandible	Length ulna	Length carpo metac.	D2P1	D2P2 (distal mus.)	Tibia Ht crescentic crest above astr.	Length skull
① Complete spec.	60.0	77.4	51.9	87.5	70.9	—	—			67.1%	86.5%									
② complete but messy	63.3	—	53.2	80.4?	70.1	9.9	—				84.3%		15.6							
③ Meso from Lompoc	est'd 67.6	incomp. 87.3	(bone from Newport fissure in impression) mounted																	
④ Coty pe Humerus ✓	~~60.2~~	83.5	—	—	—	8.6	~~7.5~~ 8.2	?					13.2							
⑤ San Pedro spec. ✓	—	—	54.6	85.4	69.6	—	—													
Type from fig. Schenck & Kay Miller	64	80	—			10.0?							16.4?							
Cotype 2 = #2 above?		82.	53																	

(much like #4) material now at LACM partly on loan from UCLA

Cotype cast (also #2)	82.4	—	—	—	8.8	7.6	—	26.5			—		—	74.7	46.1	20.3	21.9	—	—
UCLA "B" Lompoc	83.2 T 81.7	51.9	86.7?	67.7?	9.5?	—	34.8?			54.0		73.0	77.2	44.3	20.6	20.2	14.6	4.9 back 79.5
UCLA "A" Lompoc (banned)	76.2	51.6	87.7	71.7	—	—	31.9?			54.4		79.6?	73.0	42.6 42.7	20.4 19.3	21.1 21.5	15.7	5.5 back 84.0
UCLA San Pedro	—	53.9	86.2	68.1	—	—				55.1		—	—	—	—	—	18.1	—
Type (cast)	80.5	—	87.1	72.7	7.7 depth not complete 12.0	2.4?	32.7 est 30.5 int	28.4				—	73.5?	74.0	—	—	—	15.4	5.3.0 back 79.3?
LACM Lompoc (cast)	78.5	51.5 50.9	81.4	70.4	10.7 or 9.7	8.6?	29.3 est?			54.5		—	—	71.0	43.0	20.2	20.8?	12.4?	—
LACM 2703 Jennings	72.8				9.7		30.8	28.6					69.0	70.1?	37.7	19.0	17.8	16.2	4.7 back 77.0
LACM 2306 Ventura Co.	—	46.6	—	64.1	2.75 depth not complete 9.7	—	28.3	—					71.3	66.5	40.3	—	—	13.4?	5.1 back 76.8
SBMNH Alab Sp?	89.2?	—	—	—	11.6	—	—	—					—	85.3	46.7	23.7	24.2	—	—

Puffinus diatomicus

	Ulna	"2d phalanges element"	foot	tarsus	tibia tib & art. to tip
1980 Orr record					
Quirk 57:105 Tomkins	72 mm	24	48		
Miller "previous"	75, 76, 79	21	53		
Miller 1935 Sanford not pub meas but meason spec.			51, 9(?)	54, 6 tars 78 9 og tibia	69.6 85.4

	From Miller – pt Paper – Type	Holotype	# 2	# 3	Ventura species?
Humerus	80	84	82		
ulna	75	79	76		66.4
carpus		46	45		40.7
1st phalangeal		21	21		
2nd phalangeal		21			
femur	30		33		29.
Tibia "et articulatus"	73	72			63.
cnemial crest	14				
Tarsus			53		46
foot (mid toe)			53		46
coracoid axial border	27	27		26	
" costal border					
sternum at br.			30		
Skull length max	90				75.5
scapula		48			

Puffinus diatomicus ocfa 1950's?

	Length tarsus	Length femur	Length tibia to astric proj	Length tibia to tib spur	Length toe w/o claw	Length humerus	Length ulna to olecranon tip	Length radius	Length ulna to astric	Length carpo meta	Length D1P2	D2P2	Length skull back tip cran to tip beak	Length lower jaw	Lower jaw tip to centr of angle	Length femur	Humerus hd pneu fossa to dist end	Length sternum ant to tip of manub	Length cora to sut tip	Coracoid hd proj to proc
San Pedro																				
P. diat. 1 tarsmt tibia r femur r tarsmt	54.5 54.1	31.5	70.0	86.7	50.5															
P. diat. Lompoc. mass [illegible]		unrecorded by Mueller				86?														
P. diat. Lompoc. very good	51.7 51.7	NOT	recorded by Mueller 68.8? 89.8		55.3	81.7 83.3	78.2 80.0	75'	73.8	43.4 44.2	20.1 20.2	22.8 21.4	79.6	71.7	48.3	35.7?	10.5	46.4	1 abo tarsmt 66.6 tarsmt 64	
P. diat Lompoc (saw this at Stanford 4 Coryton Al 141)				1963		83.2	78.6	72.7?	73.7	46.3	21.0	20.5							26	10.5
P. diat. fine illustrat specim Lompoc [illegible]	50.0	measured	through glass 73.0. 85.8			about 75.0	½" above. 71.2	68.2	specimen	41.0	19.0	21.0	79.6	77.3	51.4	1 abo tarsmt 70.0 Tarsmt	1 abo 66	49.0?		4

Balcom canyon bird femur 75.8 72.8?

80.8
68.8
12.0

March 6 1964

Revised as P. diatomicus

	P. diatomicus Type	P. diatomicus Type revised	(frame) Miller UCLA # 17	P. diatomicus LACM A679	P. diatomicus LACM A679 revised	mihi Beel LACM 2705	LACM 2706 Ventura Co.	Semiop. San Luis Rey Valley LACM 2703	SBMNH 319	San Pedro UCLA	Capistrano Beach	White's Point Palos Verdes Specimen
Skull	86.3	86.0?	84.3	—	—		77.0	79.9? 78.2	—		87-88?	
humerus	79.4	79.6 7.6 depth int. cond.	76.5 8.2 depth int. cond.	80.0	98.5		— 7.7 depth int. cond.	74.4 10.6 dist.	86.8			
est. epi		11.6	—	11.0	10.8		10 ap.	9.6	10.3			
fr. distal		8.6	—	—	—		—	—				
ulna	74.0	74.0	72.5		71.5	74.5	67.3	70.0	89.7		74.4?	
coracoid	~~29.5~~	~~25.5~~ 29.5?	—		~~28.5?~~		—	29.8	—			
femur int.		30.4	—		—		—	—	—			
" ext.		32.5	32.1		29.3		29.0	31.5	—			39.0?
tibia tarsi	74.2	72.7	71.7		70.2		64.0	70.3	68.2	—	69.4	68.7
" complete		86.1	87.4		83.2?		—	85.2?	—		86.9?	77.4?
opemidont		14.6	15.3		14.1?		13.0?	17.0	—		17.0	11.0?
Beak		49.2 57.3 90 of shaft	48.2 57.3 90 of shaft		—		44.9	~~41.5?~~ 43.3	—		—	43.2?
								41.5? broken			78.6 90 of tibia	51.6 90 of tibia
Tarsus	—	—	50.4		50.5		46.5	57.2 43.0?	—		53.8	35.5?
middletoe	—	—	54.2		53.2		52.0	—	—		53.9	43.5? (incomplete unmeasurable) 43.8
Carpus	—	—	42.7		43.6		—	38.3	46.6			39.0
D2P1	—	—	20.1		20.1		—	18.1	23.2			19.7
D2P2	—	—	22.1 84.9		21.5? 85.1		—	18.4 74.8	24.3 94.1			19.4 76.4
D1P1	—	—	19.1		20.7		—	—	22.3			
upper part carac. to lower end glen. facet		10.7?	—		11.3		—	—	—			
low. margin of Dpth sh humerus		75.5 6.7	79.6 6.8		— 6.2		71.0 6.0	69.5 6.5-7.2?	7.2+?		73.4	

81.9 20.8
44.4 24.7
5-3.9

33.5
11.5
7.0
52.0

# of P. diat. from Sampoc.

4

Stanford
"Cotype"
"Cotype B"
" " C
" " D"

UCLA
✓ 1 framed
1 very poor
2 quite good

U.C Berkeley
Type
LA mus.
A 679

Cal Acad
Orr round

Oct 31, 1961

Fratercula arctica — recorded

meas. at U.C.L.A.

L.A. Co. mus.

U.C.L.A. specimens measd since Miller recorded except ≡#20? included in size range in HH 1949 paper

	Miller 1925 Recorded: Type	Topotype	#2	Miller 1925 illus. but not meas. (≡#17?)	Miller 1935 San Pedro illus. but no meas.	Range in recorded specimens	UCLA Messy spec. 84, 2nd-3?	UCLA complete specimen	L.A. Co. mus. ≡#13	Orr record 1940	HH 1949 paper (illus. HH)
Length humerus	80	84	82	75.0	—	75 – 84 (84?)	? 89.3	81.7	80		82.2 or 75.2
Ulna	75	79	76	71.0	—	71 – 79		78.2	73.9	72	
Carpus	—	46	45	41.0	—	41 – 46		43.4 (44)	—		
Ph. 1		21	21	19	—	19 – 21		20.1	20.6		
Ph. 2		21	—	21.?	—			21.4 (23.8)	22.0	24	
Femur	30	—	33	—	31.5	30 – 33		—	30.1		30.5
Tibia	73	not shown	—	69.0	70.0	69 – 73		68.8	70.7		72.2 HH
Tarsus	—	—	53	50.0	54.0	50 – 54		51.7	51.2	"boot" 48?	51.6
Coracoid (left)	27	27	—	—	—	8 – 27	28.5	—	—		
Skull	90	—	—	79.6	—	79.6 – 90		—	—		
Car. to humerus	33.7	32.1	—	—	—	32.1 – 33.7	32.8	—	—		
Hum. – skull	88.9	—	—	94.1	—	88.9 – 94.1	—	—	—		
Ulna – skull	83.3	—	—	89.3	—	83.3 – 89.3	—	—	—		
Tarsus to humerus	37.5 —	—	40.3 64.6	66.5	—	37.5 40.3 64.6 – 66.5	—	63.3	64.1		
Tarsus to ulna	—	—	69.7	70.5	—	69.7 – 70.5	—	66.1	69.3	64.6	(?)
Tarsus to tibia	—	—	—	72.4	77.1	72.4 – 77.1	—	75.2	72.2		
Humerus or ulna to humerus	41.1 93.7	93.2	92.7	94.7	43.0 —	92.7 – 94.7	—	95.6	92.5		
Tibia to ulna	97.5	—	—	97.3	—	97.3 – 97.5	—	88.0	96.1		
Carpus to humerus	—	54.7	54.9	54.7	—	54.7 – 54.9	—	53.7	—		
Carpus to ulna	—	58.3	59.2	57.7	—	57.7 – 59.2	—	56.3	—		
Ph 1 to carpus	—	45.6	47.7	46.4	—	45.6 – 47.7	—	46.6	—		

unpublished

A New Locality Record for the Miocene Shearwater, *Puffinus diatomicus* Miller

In November, 1956, Mr. Eugene Nicholas of Oxanrd, California and Mr. Harry Shetrone of Santa Susana presenteed the Museum with slabs of Miocene shale from Ventura County bearing bones of fossil shearwater. Although the specimens were collected independetnly and neither young man knew of the other's find, the slabs came from the same spot and contained parts of the same individual bird. The locality is in Balcom Canyon, at the southwest edge of Oak Ridge, about midway between Santa Paula and Moorpark on a NE-SW air line.

The bird skeleton represendted on Mr. Nicholas' slab includes partial skull, the wing bones of the right side (lacking the phalanges and the proximal half of the humerus), the complete right leg with toes in place, tibiotarsus and tarsometatarsus of the left leg, sacrum, and miscellaneous vertebrae and ribs. The complete skull, and cervical vertebrae appear on Mr. Shetrone's slab.

~~Except for its small size, the bird skeleton appears to agree with previously known specimens of Puffinus diatomicus Miller~~

The matrix is a soft shale, containing some diatomaceous material, but is not diatomite such as that which forms the matrix for the type specimen of P. diatomicus, at Lompoc, California

Exeept for ts small size the bird skeleton appears to agree with specimens of Puffinus diatomicus Miller, particularly as follows: similar in general size and characters to the living Puffinus opisthomelas, but with legs relatively longer and wings shorter; tarsometatarsus relatively deeper of shaft; middle toe as long as, or longer than tarsmetatarsus. Of the twelve specim ns of P. diatomicus reported (Miller, and De May, 1942, pp. 74-75) measurements are available for eight; some of these were previously recorded, others were made especially for this study.

Specimen LACM #2704 Ventana Puffinus

Tarsus		Toe	Tibia		Femur		Ulna	Coracoid			Humerus					
Length	Depth shaft	Length middle toe	Length tibia	Depth Ext cond.	Ext Length	gr. Length	Depth prox	Length	Depth head	Ht Ml proc.	Depth int cond.	Ht ext proc	Depth int sh abdom cond.	Depth sh near mid	Br. sh same plane	Ratio Br to Depth
46.5	4.0	47.5	64.2	6.7	28.9	66.5	8.6	40.0	10.0	7.0	7.8	9.0?	4.6	5.5	3.7	67.2%

52 : 81.7 = 15 : Y
3.6 : 5.5

Pygopus diatomicus # 29078 Sunset. Cal. Acad. Sci
reported by Orr to Conder

Humerus	82.2 lst ectepicond. 9.9 from dist end
Ulna	75.25 (gr. length)
Tibio	72.2 72.2? of 77.2 (with cart?)
Premaxilla	11.8
Femur	51.6
Pygostyle	12.8
Br. dist. end humerus	11.2
Length femur	30.5

39170 Sea Cliff Sio. of Sloishacker

Uria aalge ?

cal acad sci

Humerus	87.5
Ulna	67.6
carpo	45.0
Coracoid	38.35

P. diatomicus at Stanford identified by L. Miller

Butt # 2284 (?) carpo + 2 phals attached to M2 + ulna + rad. both incomp. distals
slab 5½ x 3½"

Length carpo	40.15	
D2 P1	20.4	40.4 20.8 ?
D2 P2	20.0	19.8 ?

ulna length (?) 73.8

Coltype Paratype (#5) humerus + carpus + others (probably a femur) fish bones mixed in
shaft crushed
ectepi proc. dorsal slum (humerus slab 5½ x 4½

[Miller's lot # 14 ?]

Length humerus	80.2
Length deltoid (?)	21.5
Least depth shaft	6.35
(?) femur length	32.1

+ radius + radiale

√ Slab "Coltype" 6½ x 10 1/2" humerus, ulna, radius, carpometa D2 P2 + D2 P1 + D1 P1

Humerus	83.9	
Br. distands	8.8	20.4 D2 P1 } 41.9
Ulna	77.8	20.9 D2 P2
Carpometa	44.8	21.1 D1 P1

could be Miller's "coltype" cast of which is at LACM, (4 in box)

√ Slab coltype "C" (must be coltype 3 of Miller)
coracoid to int. angle + tip of head 25.0 ap.

Br. Sternal art. proc.	33.1
" " middle	28.0
length sternum	55.5 - 58.3 (including manubrial prominence)
Br. sh. humerus	5.6
Br. prox. "	11.9
length "	71.4 ap. (dista broken away

10 X 10 ?
+ Trochl

Length femur fair 67.6
Length skull 77.4
(skull to humerus 108% as in type)

2 coracoids with proximal end missing
partial humerus sternum
dorsal vine sternum
bicipital crest straight line slant, (some of these after more mature?)

Trip to Berkeley April 1963

Puffinus griseus tarsus

The ectepicond. proc. is complete distally but a small tip is missing at prox edge.

Puffinus mitchelli type.

The tip of ectepi proc. is missing & proc. looks slightly water worn. The external condyle is incomplete

	mitchelli	griseus
br dist. condls.	8.6,	7.3
dist prox ext cond to tip ectepi proc.	11.1	9.7
but proc. at base	3.4	3.2
length proc.	3.7	4.4
gr. depth sh	7.0 or 2	6.3
least " "	6.8	6.3
Depth ext. cond	7.9	6.6
dist bet. dist edge ectepi proc. & prox round ext. cond.	9.2 ?	8.8 ?
Br. sh	4.15	3.2
but facet above with. cond. (dist surface broken)	7.3 ??	6.2.5

broken prox'ly in incipient

65% depth in griseus from dist end

97) 63.0
58.2
1480

Cerne between ectepi proc & ext. condyle deeper & narrower in griseus than mitchelli

Cal. Acad. Sci.

Type of Puffinus in collection? Humerus dist end

	Puf. griseus ectepi condyles #5223	Puf. sp. #5224 condyls.	
Br. distal end	8.75 (9.5)	9.0 (10.0)	(tip of ectepi is broken) & along upper edge palmar side)
Depth mit. cond.	9.6		
" ext "	7.3		
Ht ectepi above dist. end	10.3		
length of prox ectepi	3.45		
Ht prox. " at base	3.9		
gr. Depth shaft	5.9	— 6.8	
br. sh.	3.7	— 4.0	
Br sh above proc	4.5	— 4.7 ?	
dist. but tip ect. proc. & prox round of ext. cond	6.0		
Depth ext cond	7.5	— 8.1	
Ht ext cond	4.0	4.9	
Ht mit cond	3.3	3.9	
mit. facet above mit cond.		8.4	

Depth mit. above condyle to facet 6.15

Depression prox edge is about on line with prox. margin of ectepi proc.

upper margin of ectepi forms ∠ with shaft - tip appears pointed with but broken!

Pliocene Shearwaters — from Fossil Checklist

Puffinus felthami Howard, 1949

Late Lower Pliocene - near Corona del Mar

Carn. Inst. Wash. Publ. 584; 194-195, pl. 2, fig. 4,

Type humerus, referred tarsus & wing phalanx.

larger than P. griseus & P. pacificus

measurements

	Type	Cotype	P. griseus
Humer. length from end deltoid only	71.2	—	83.6 - 88.0 comp.
Br. dist.	8.5		8.8 - 9.5
Ht. epi. proc.	11.0		11.4 - 11.7
Br. sh.	3.8		3.6 - 4.2
Tarsus prox. br.		7.5	7.9 - 8.1

Puffinus kamtschoffi Howard 1949

Mid Plio (San Diego formation) Wash. Blvd. Fossil Quarry San Diego

Carn. Inst. Wash. Publ. 584: 187-188, pl. 2, figs. 3-5

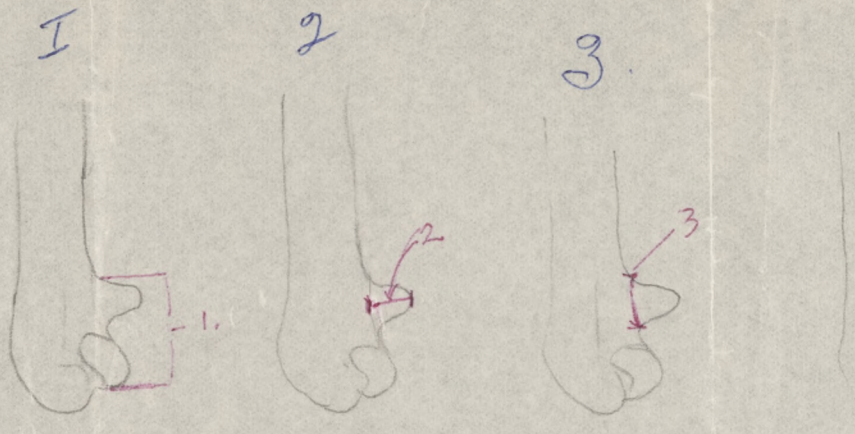
Type tarsus, referred: ~~paired~~ humerus, femur, tarsus, prox tib prox, carpus.

Size similar to P. griseus including tarsal length

" " " P. diatomicus also, but tarsus shorter

Measurements

	Type	Cotype humerus	referred	P. diatomicus	P. griseus
Length tarsus	45.2 (added 45.5)		47.0	51.9 - 54.6	42.8 - 47.2
length hum.			80.5 (added 81.2) (85.0)	77.4 - 87.0	77.5 - 85.1
Br. dist. hum.		7.3	7.5 - 8.0	—	7.1 - 7.6
Ht. epi. proc.		9.4	9.2 - 10.0	8.6 - 9.9	9.1 - 10.3
Br. sh.		3.5	3.0 - 3.5	—	3.2 - 3.4
Tarsus prox br.	6.7		6.8 - 7.1	—	6.0 - 6.7



(slightly exaggerated) general shape of ectopicondylar process in L.A. mus, P. diatomicus from Lompoc. Does type have this curve? (drawing here is enlarged)

Traced from photo of P. priscus (enlarged)

These measurements needed:

on P. priscus
P. mitchelli
✓ P. diatomicus, type at Berkeley

Did you make any comparisons with the type of P. diatomicus when studying P. priscus + P. mitchelli? I realize the size alone was distinguishing, but if you made any other observations, I would appreciate learning of them. None only as regards relative lengths of ~~limb~~ segments

AR

Ectepicondylar Process in Puffinus

	opisthomelas (4 birds)	tenuirostris (2 birds)	creatopus (1 bird)
Howard's sketch # 1	10.1mm - 9.5	10.5 - 11.5	11.8
" " 2	3.9 - 5.5	5.2 - 6.0	7.0
" " 3	4.1 - 4.7	5.0 - 5.5	5.4
Length of humerus	80.7 - 84.1	90.5 - 100	115.9

F-243
F-200
E.D.M./F-243

Shacklooth Hill
Paffinus

Rush Lept

R P. Mitchelli Loye Miller
C P. priocus " "
L P. inceptor Wetmore

Extinct Fossil Shearwaters — by sizes

largest to smallest.

		P. griseus	P. opisthomelas
Maryland:			
Puffinus species	Br. dist. hum. 14.9, sh. 6.7		
Puffinus conradi Miocene	Br. dist hum, 13,4	8,8 – 9,5	7,1 – 7,6
	Br sh " 7,1	3,6 – 4,2	3,2 – 3,4
Puffinus species Calif. Sharktooth Hill Miocene	smaller than P. conradi	? ulna	
Puffinus inceptor Miocene	Br. dist. hum. 12,2	[Br. condyles only = 8,75	
	Br. sh. " 5,9	[Note: 5,9 = depth; breadth is only 3,7 mm]	
Puffinus species Miocene	Br. dist. hum. 12.8		
P. mitchelli	Br. sh 6.9		
P. species	condyles Br. dist. hum. 8,6, sh depth 7,1		
Calif. Corona del Mar Pliocene	condyles Br. dist 7,3, dist sh 6,3, sh sh 4,1		
	sh sh 3,6		
Puffinus felthami	Br. dist hum. 8,5		
	Br sh " 3,8		
	est'd length from humerus length from delt. ford 71,2	83,6 – 88,0	61,3 – 67,1
	Tarsus prox 7,5	7,9 – 8,1	6,0 – 6,7
Calif. San Diego Pliocene			
Puffinus kanakoffi	Br. dist hum, 7,3 – 8,0		
	Br sh 3,0 – 3,5		
	length (total) 80,5		77,5 – 85
	Tarsus distal 45 – 47,0 (55 – 58% hum.)		42,8 – 47,2
	" prox 6,8 – 7,1	7,9 – 8,1	6,0 – 6,7
13½% proportion of opisthomelas tarsus slight for P. diatomicus			
Calif. Sanger + Other Miocene			
Puffinus diatomicus	length deltoid 60,0 – 64,7 (? – 67)		
	length hum 77,4 – 87,3 (8,2 ?)		
drops same as opisthomelas legs longer	Br. dist. ulna (min 72) – 79		78
	carpus 45 – 46 (59 – 61% ulna)		45 (57% ulna)
	Tarsus (min 48) 51,9 – 54,6 (66 – 68% ulna, 72% tibia, 66% hum.)		45 (57% ulna)
	Femur complete 80 – 87		86
	Tibiotarsus 72 – 73 (91 – 97% ulna)		65 (83% ulna)
Calif. Balcom Canyon, Ventura Co.			
Puffinus species?	Est'd hum, based on ulna 72,5		
	length ulna 66,0		78
	carpus 39,7 (59% ulna)		45
	Skull 75,5		86
	Tarsus 46,0 (69% ulna, 73% tibia)		45 – 52
	Tibia 63,3 (94% ulna)		65 (83%)
proportions as in diatomicus, but 10% smaller than min. of diatomicus	est'd hum. (or 85% of ulna = 90% hum) = 73 mm		
Calif. Tepusquet Canyon			
Puffinus species			
	humerus ulna	(95% hum.)	

Puffinus Calhouni

br. dist humerus 7.1

br mid shaft 3.3

br above distend 3.0

Puffinus Tedfordi

tarsus only br prox. 6.8

br sh 3.3

1.7.62

Mod figures from type skulls

Type - Puffinus diatomicus - latex cast

Skull length 86.3 mm

79.1-79.4 humerus " 77.5 "

" lt ectepicpr. 11.5 or 6

" br. dist condo. 7.5-7.7

29.5 coracoid 27.5-27.8

femur int. length 29.5 } ave. 30.5

" ext " 31.3 }

74.2 to art. surface tibia length to art. 70.6

" lt cnemial proc 13.3 - 14.5 - compares with Woodland Hills (13.3 just the proc) 14.5 from astricial attachment for tip of process

74.0 or 71.7 Recent ulna - gr. length 71.5

Dept shaft 6.2 mm
Dpth int. side dist end 5.0 mm

Base of ectepi - 4.6
projection " 4.5
from shaft

14.5 in woodland Hills but 17.5 -

Humerus distally -
Muscle depression of palmar side
Prox edge of it is distal to prox. edge of ectepi proc.
whereas all Lum forms it is at or proximal to it

Humerus prox'ly
Head projects high above med. prox but is relatively narrow 11.1 mm
Lum forms head much lower
Very small (3 mm high x 1.8 broad) ectepicond proc (?) (= flat surface on palmar edge of int. side of shaft (1) distally, above ▽ to int. side from int. condyle
low in position - top edge only very slightly prox. to prox tip of ext. condyle ▽ well below distal margin of ectepicond proc.
Hyter in all Rec. forms examined

11.7 typ head diheder (3.4 Lum) possibly more displaced due ▽ crushing (8.3 Woodland Hills)

Vent. 3.1 mm lt of ectepi at dist side of ectepi

375 14740
4656
90°

5 1.5
5 8 4

from cast (which is apparently smaller than the original whose length is given as 83 mm for humerus + 79 for ulna

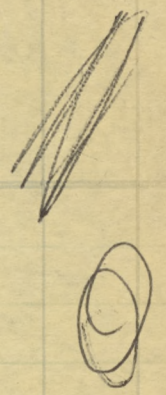
	Length humerus	Br. Distal humerus	Length ulna	Length carpo-m	Length Tibio-	Length tarsus	Br. prox. Tarsus	Ratio ulna to hum.	Ratio carpus to ulna	Ratio tarsus to humer	Ratio tarsus to ulna	Ratio carpus to hum	Ratio Tarsus to tibia	gr. length shield	Ratio femur to tibia	Length femur	Ratio carpus to tarsus	length toe (mid)	Remarks
P. conradi	—	13.4	—	—	—	—	—												
P. inceptor	—	12.2	—	—	—	—	—												
P. feltham	90?	8.5	—	—	—	—	7.5												
P. transhaffi	80.5	7.3-8.0	—	—	—	45-47	6.8-7.1	—	—	55.4-58.3									
P. diat. corpo	83	8.2?	75.5	41-46.3	68.8?	50?													
P. diatomnus	77.4-85.3	8.2?	71-79	45-46	72-73	51.9-54.6	—	92.1%	96.6%	55.2-59%	62-66.6	64.6-70.2	53-55.6	79.6-90	41-45	30-31.5			
Ventura spec.	est. 72.4	—	66.1	40.0	63.3	46.0	—	91.1?	59.9%	63.4?	69.5	56.8?	72.6	75.5	46.1	29.2	86.0	46.4?	
Tejon spec.	90?	—	85.7	49.3	—	—	—	95.2%	57.5%	—	—								
		1/5 per hum 8.																	
P diat. Type	80		75	—	73	—								90		30			
Cotype	84		79	46	—	—								—		—			
good adult specimen	75		71	41	69	50.0								80		30?		50.1	
"No. 2"	82		76	45	—	53.0										33		53.0	
"No. 3"		carpals only																	
Acad.			72	other measr. said to be same as previous record														48.0	
San Pedro					70	54.										31		51	
UCLA	81.7	8	78.2	43-44?	68.8	51.7													

The crucial proximal ratio is 23% (+) of the length of the tibia
* articular surface in the illus. of P. diat. (not type)
† The San Pedro specimen

Fibers Projectiles

1917
mean

	Str dyst end	Depth ext cond	Depth int cond	Int int cond (auth)
Newport, fossil grodem Bi 50	7.1	7.7	7.9	5.2
	7.2	7.2	7.7	5.0
Bi 577	7.0	7.3	8.0	5.1
Bi 64	7.2	7.6	8.0	5.2
Bi 49	7.6	7.8	8.2	5.3
	85'			
	79'			
	61			



Passerini Valenti

1er ① 1437 – tuy Salpinctes obsoletus (pair) humeri not triangular

humeri not ~~T~~ ② 1114 – same size as 1437 but deeper forsa below head 3 lumen could not ~~be~~ be triangular like Salpinctes sp.
2 dif. inside 2R, 1L

③ 1461 – dist. humeri differs from ~~Thryo~~ Troglodytes
dist humeri of 1114

④ {1250-2 / 1323 / 1114 later} might be same ? humeri (humeri prox)

⑤ 1615 tuy (cones be crew)

~~1114 = larger = cords =~~

④ 1250-3 carpus (sy could be with the humeri of 1250-2 et al

1249 Fringillid

fossil specimens of shearwaters representing 3.7.64 Not published, ?

Three new locality records for the genus Puffinus are now at hand. Each specimen represents the impression plus broken bone fragments of several associated skeletal elements preserved in a slab of Miocene shale, a preservation that of the several specimens referred to Puffinus diatomicus Miller from Santa Barbara and Los Angeles counties, California. Since the description of P. diatomicus (Miller, 1925), five other species of shearwaters have been recorded from the Tertiary of California. Two of these are from the Pliocene, P. kanakoffi Howard from San Diego, and P. felthami Howard from Corona del Mar, Oragne County; three are from the Miocene of Sharktooth Hill, Kern County: P. inceptor Wetmore, P. priscus Miller and P. mitchelli Miller. Another Miocene species, previously described from Maryland (P. conradi Marsh, 1870) completes the North American Tertiary record.

The gross contours of practically the entire skeleton of P. diatomicus are known from impressions and partial preservation of bone in several slabs of Miocene shale. The other Miocene species were each described from an isolated distal end of humerus; the Pliocene species are known from two or three elements each, including the humerus. The seemingly more complete skeletons of P. diatomicus lack the detailed characters of individual bones such as serve to distinguish the other species. The three specimens now at hand also lack these details. It became necessary, therefore, to make a very thorough study of the types of each species, in an endeavor to establish some criteria applicable to both types of preservation.

Characters of P. diatomicus as here used in comparison with the new specimens are based on a personal study of the type (Univ. Calif. Mus. Paleon. no.) and an excellent reverse (mold) made from the type that provides an image of the bones in relief. As the type specimen does not include tarsometatarsi and pedal phalanges or carpometacarpi and wing phalanges, two other excellent specimens

Three partial skeletons of shearwaters preserved in Miocene shale, constituting three new locality records for this group, are now at hand. Each specimen represents several associated elements preserved in a slab of shale, a type of preservation not unlike that of the several specimens referred to Puffinus diatomicus Miller from Santa Barbara and Los Angeles Counties, California. Since the description of P. diatomicus (Miller, 1925), five other species of shearwaters have been recorded from the Tertiary of North America. Two of these are from Pliocene deposits, P. kanakoffi Howard from San Diego, California, and P. felthami Howard from Corona del Mar, Orange County, California; and four are from the Miocene: P. inceptor Wetmore, P. priscus Miller and P. mitchelli Miller, all from Sharktooth Hill, Kern County, California. A sixth species, P. conradi Marsh, described many years before (1870)

from the type locality, Lompoc, California, identified by Loye Miller, were studied (UCLA no. and LACM no.). The UCLA specimen includes all of the elements found in the type plus the missing terminal bones of the limbs; the LACM specimen is complete except for the skull; ~~The proportions in each of these specimens leave no doubt as to their assignment to P. diatomicus.~~ The types of each of the other species were studied and casts were also available for comparative study.

Based on the three specimens of P. diatomicus named above, characters of P. diatomicus are as follows: humerus ~~shorter than skull~~ (90 - 92 per cent of skull); ulna ~~also shorter than skull~~ (86 per cent) ~~but long in proportion to~~ length ~~of humerus as compared with these elements of P. opisthomelas~~; also in comparison ~~to P. opisthomelas,~~ tarsometatarsus ~~longer~~ (64-66 per cent of humerus; 69 - 70 per cent of ulna; 70-72 per cent of tibiotarsus; middle toe longer by 5-8 per cent than tarsometatarsus; cnemial crest of tibiotarsus slender and relatively short, ~~as in P. opisthomelas~~ (18.5 - 21 percent of length of tibiotarsus measured to articular surface); ectepicondylar process of humerus pointed, upturned, and situated well proximal to condyle. This latter characteristic distinguishes the humerus of P. diatomicus from that of any of the other North American fossil shearwaters; in addition, the reverse mold of the type suggests that the brachial impression is much more distally situated than in the other species, the upper edge of the impression being well below the proximal contour of the ectepicondylar process.

LACM specimen no. 2706 ~~agrees with P. diatomicus in proportions but is smaller throughout~~. This specimen was collected by Eugene Nicholas, Blanche Nelson and Harry Shetrone in Balcom Canyon, on the southwest edge of Oak Ridge, Ventura County. The skull, leg bones and part of the wing are represented. ~~The diagnostic~~ proportions

of relatively short ulna as compared with length of skull and leg bones are in agreement with those of P. diatomicus, the cnemial crest of the tibiotarsus is short, the middle toe longer than the tarsometatarsus, and the ectepicondylar process of the humerus upturned and apparently relatively high above the distal end (although as the humerus is incomplete, a ratio cannot be established). See Table 1. In actual size, however, the five measurable individual elements (skull, ulna, femur, tibiotarsus, tarsometatarsus) are from 8 to 16 per cent shorter than the corresponding elements of the type. In a series of twelve skeletons of existing Puffinus puffinus opisthomelas, the minimum varies from 9 to 11 per cent of the maximum depending on the element. A study of Murphy's (1956:table 1) measurements of tarsometatarsus of the eight living races of Puffinus puffinus, reveals a size range of 15 per cent in typical P. puffinus and of 28 per cent from smallest P. p. gavia to largest P. p. puffinus. The Ventura County fossil is, therefore, assigned to P. diatomicus with the suggestion that it may have been racially separated from the typical form. Although the locality is not far removed from that of typical P. diatomicus geographically, the possibility of geologic separation should not be overlooked. The Ventura County locality and the Lompoc locality have not been analyzed in this regard.

LACM specimen no. 2703 was submitted by Mikè Jennings, who collected it on Old Topanga Canyon Road near Ventura Blvd., Woodland Hills, Los Angeles County, California. This locality is about 7 miles west of that from which a specimen previously recorded as P. diatomicus was recovered (Howard, 1962:312). The main skeletal elements are represented, incompletely in some instances, on obverse and reverse slabs; Distinctions compared with P. diatomicus are as follows: humerus and ulna longer relative to

humerus and ulna relatively longer in proportion to length of skull and length of carpometacarpus and wing phalanges; cnemial crest of tibiotarsus markedly longer; ectepicondylar process of humerus straighter, stubbier and situated closer to distal end. The tarsometatarsus is incomplete; its position relative to the broken end of the tibiotarsus suggests, however that it fell far short of attaining the relatively great length characteristic of P. diatomicus. The humerus is seemingly deeper of shaft than in P. diatomicus. Admittedly depth of shaft could be affected by crushing of the bone before the impression was made, but the appearance of the remaining bone does not suggest extensive distortion. The San Fernando Valley specimen is distinguished from both Pliocene species by shorter, heavier humerus and shorter tarsometatarsus. The depth of shaft as well as size, shape and position of the ectepicondylar process are in accord with the type humerus of P. priscus, although the latter appears to be about 4 per cent larger. The San Fernando Valley specimen is, therefore, tentatively assigned to P. priscus.

of relatively short wing bones as compared with length of skull and leg bones are in greement with those of P. diatomicus (see table). In actual size, however, the six measurable individual elements (skull, ulna, femur, tibiotarsus, tarsometatarsus) are from 8 to 16 per cent shorter than the corresponding elements of the type. In a series of twelve skeletons of existing P. opisthomelas, the minimum varies from 9 to 11 per cent of the maximum depending on the element. A study of Murphy's (1956:table 1) measurements of tarsometatarsus of the eight living races of Puffinus puffinus, reveals a size range of 15 per cent in typical P. puffinus and of 28 per cent from smallest P. p. gavia to largest P. p. puffinus. The Ventura County specimen is therefore assigned to P. diatomicus with the suggestion that it may have been racially separated from the typical form.

the cnemial crest of the tibiotarsus short, the middle toe longer than tarsometatarsus, and the ectepicondylar process of the humerus upturned and apparently relatively high above the distal end (see table) although as the humerus is incomplete a ratio cannot be established.

A Problem in the Sutdy of Miocene Marine Birds of Southern California

Nearly complete skeletons of fossil marine birds found in the Miocene shales of southern California, though "beautiful" specimens, are not always readily assignable. Bones are crushed or partially (in some cases totally) represented only by impressions, and none can be removed from the matrix to be studied in all aspects.

Four species of The problem at hand concerns the California Miocene shearwaters (genus Puffinus) of which four species are known: Puffinus diatomicus, from several slabs of shale containing impressions of nearly complete skeletons; and three species from Sharktooth Hill, each described from a single, well preserved, distal end of humerus free from matrix. At the Los Angeles County Museum are four new specimens of Miocene Puffinus, each in a slab of shale, each from a locality in which the genus has not before been recorded. Two can be referred to P. diatomicus on the basis of general proportions. The others differ from Pl diatomicus and evidently represent two other species. The humerus is present in each specimen, but only in a limited fashion general outlines can it be compared with those from Sharktooth Hill. On the basis of one measurable character that can be observed and measured, the specimens suggest two of the Sharktooth Hill species, and they will, therefore, be so recorded, albeit, tentatively. This decision, based on such slim evidence, is open to criticism. I submit as justification for this decision, that a tentative specific record invites future investigators to consider these specimens as additional material may come to light at Sharktooth Hill, whereas an unassigned generic record is often overlooked.

The decision to record these specimens under the specifically neutral name Puffinus sp.

Should the Are the interests of science better served by the conservative listing of the spc. as P. sp. or by recording them under the specific names of the spc. which they seem to resemble? I feel that the latter course is most likely to invite future investigation and is, therefore, the wiser,

Skulp Apnt 1963 (already recorded

Descriptions

Specimen no. 2705 in the Los Angeles County Museum collections came from the San Fernando Valley, Los Angeles County. It was collected in 1961 by Michael Bell, on Del Gado Drive near Sapulveda and Ventura Blvds., Sherman Oaks. This same locality yielded, as well the second known specimen of Osteodontornis orri Howard (see Howard and White, 1962) and a small slab containing the crushed leg bones of a sulid, now referred to Sula willetti Miller. Wing and leg elements are incompletely represented in the shearwater specimen; coraoid, humerus and femur are missing, the skull is present but lacks the posterior portion of the cranium. All measurable elements fall within the size range of P. diatomicus; proportions, also, are the same. The specimen is ~~therefore~~ assigned to this species. See table for detailed measurements compared with those of other specimens of shearwaters.

Specimen no. 2706, L.A.Co.Mus. coll., agrees with P. diatomicus in proportions but is smaller throughout. It was collected by Eugene Nicholas, Blanche Nelson and Harry Shetrone in 1956 in Balcom Canyon, on the southwest edge of Oak Ridge, Ventura County. The skull, leg bones and part of the wing are represented. The diagnostic porportions of relatively short wing bones and long tarsometatarsi which characterize P. diatomicus are noted in this specimen (see table) But in actual size the six measurable individual elements are from 8 to 16 per cent shorter than the corresponding elements of the type of P. diatomicus, and 14-17 per cent shorter than the maximum specimen of P. diatomicus. In a series of twelve skeletons of present-day P. p. opisthomelas the minimum varies from 9 to 11 per cent of the maximum depending on the element. A study of Marphy's (1956, table 1) measuements of tarsus of the eight living races of Puffinus puffinus, reveals a size range of 15 per cent in typical Puffinus puffinus and of 28 per cent from smallest Puffinus p. gavia to largest P. p. puffinus. The Ventura specimen is therefore assigned

to P. diatomicus with the suggestion that it may have been racially separated from the typical form.

The other two ~~shearwater~~ specimens under consideration at this time were submitted for study by Mike Jennings of Woodland Hills, California, and Phil C. Orr, of the Santa Barbara Museum of Natural History, respectively. The Jennings specimen was collected in 1960 on Old Topanga Canyon Road near Ventura Blvd., Woodland Hills, San Fernando Valley, about 7 miles west of the locality from which L.A. Co.Mus. specimen no. 2705 was recovered. The main skeletal elements are represented (although incompletely in some instances) on obverse and reverse slabs. Distinctions as compared with P. diatomicus are as follows: coracoid actually as well as relatively longer (approximately 40 per cent of length of humerus); humerus, ulna, carpometacarpus and tibiotarsus shorter; femur equal in size, thus relatively longer; cnemial crest of tibiotarsus actually as well as relatively longer (approximately 24 per cent of length of tibiotarsus to articular surface); ectepicondylar process of humerus situated nearer the distal end; shaft of humerus seemingly deeper. Admittedly depth of shaft could be affected by crushing of the bone before the impression was made, but the appearance of the bone does not suggest extensive distortion. Unfortunately the tarsometatarsus is incomplete; its position relative to the broken end of the tibiotarsus suggests, however, that it fell far short of attaining the relatively great length characteristic of this element in P. diatomicus, and more nearly approached that of P. p. opisthomelas in size. Only in proportions of short humerus and ulna relative to skull length, is the Woodland Hills specimen in agreement with P. diatomicus.

It is difficult to compare the Woodland Hills specimen with the other Tertiary shearwaters, all of which are based on isolated bones. It can, however, be distinguished from either of the California Pliocene species

other details noted in the descriptin of P. priscus (Miller, 1962, p. cannot be ascertained on the San Fernando Vlalley specimen. It is

on the basis of a shorter, heavier humerus, and apparently shorter tarsometatarsus. As far as comparison can be made with the Miocene species, the depth of shaft of the humerus, as well as size and shape of the ectepicondylar process and its height above the distal condyle suggest similarity with P. priscus Miller, ~~although the type of the latter species appears to be about 4 per cent larger.~~ The breadth of distal end and other details noted in the description of P. priscus (Miller, 1962) cannot be ascertained on the Woodland Hills specimen. It is, therefore, with considerable reservation, that I tentatively assign it to P. priscus, rather than to identify it merely as Puffinus, sp. It would be obviously indiscreet to establish still another species on the basis of this specimen without further knowledge of the species from Sharktooth Hill.

The Santa Barbara Museum's specimen bears that museum's number 319. It was collected by Phil C. Orr in 1956 at the Tepusquet Canyon quarry (Santa Barbara County) from which the type of Osteodontornis orri Howard was taken. Wing elements only are represented on this slab. All except the carpometacarpus are longer than the corresponding elements of the good specimen of P. diatomicus. There is, however, one very poorly preserved specimen of the shearwater from Lompoc in the University of California at Los Angeles collections in which the humerus appears to be nearly as long. Its length varies with the position of the calipers from 86 to 87 mm.; in a previous record of range in size of P. diatomicus (Howard, 1949, p. 188) the figure of 87 mm. was recorded as a maximum length of humerus based on this specimen. A coracoid ~~is~~ associated with the humerus in the UCLA specimen; ~~this~~ appears to be nearly 3 mm. shorter than the Tepusquet Canyon coracoid. The proportions of the wing bones to one another clearly set this specimen apart from P. diatomicus. In relation to the humerus, the ulna and coracoid are longer (98 and 36 per cent of humeral length, respectively), the carpometacarpus shorter (52.7 per cent of the humerus).

The meager comparisons possible between the Tepusquet Canyon specimen and the other California Tertiary shearwaters show the humerus of the Santa Barbara specimen to be heavier than that of either P. Kanakoffi or P. priscus, and to have a shorter deltoid crest than that of P. felthami. The shape of the ectepicondylar process distinguishes it from the type of P. conradi. Wetmore (1926, p. 463) describes this process in P. conradi as forming an abrupt angle with the shaft of the bone at its lower margin and rounding more gradually on its upper margin; the reverse is true of the Santa Barbara specimen. Depth of shaft and height of ectepicondylar process above the distal end are close to these measurements in the type of P. mitchelli, but the process protrudes from the shaft more markedly. It should be noted, however, that Loye Miller, who kindly took this measurement for me on both P. priscus and P. mitchelli, was doubtful whether the process is complete in the type of P. mitchelli. With considerable reservation, the Santa Barbara specimen is tentatively assigned to P. mitchelli.

Abstract:

Four specimens of Miocene shearwaters are recorded from southern California. Two are assigned to Puffinus diatomicus Miller, of which one may represent a smaller race than the typical form; another is tentatively assigned to P. priscus Miller, known previously from a distal end of humerus; and the fourth is tentatively assigned to P. mitchelli Miller also known only from the type distal end of humerus.

Four partial skeletons of Miocene shearwaters in shale are recorded from southern California.

Condor, 1962, 64: 512-513

A New Locality Record for Miocene Puffinus diatomicus and Sula willetti. In reporting the occurrence of Osteodontornis orri Howard in a Miocene deposit at the end of Del Gado Drive, on the north slope of the Santa Monica mountains, Sherman Oaks, California (Howard and White, Los Angeles County Mus. Contrib. Sci., 52, 1962), a shearwater and a sulid were noted as occurring in the same deposit. These have now been studied and are referred to Puffinus diatomicus Miller and Sula willetti Miller, respectively. Both specimens consist of associated skeletal elements impressed on slabs of diatomaceous shale.

The incomplete skeleton of Puffinus lacks the coracoid, humerus and femur. The skull lacks the posterior portion of the cranium. The specimen was compared with three representatives of P. diatomicus from the type locality at Lompoc, California; a cast of the type was also available. Both in length of individual elements, and relative lengths of one element to another, the Sherman Oaks skeleton falls within the Lompoc series.

The skeleton of Sula is represented by the leg bones only. Each of these bones is approximately 10 per cent longer than the measurement given by Miller (Carnegie Inst. Wash., 349, 1925:114) for the corresponding element of the type specimen of Sula willetti Miller: femur 57.3 mm. (52.0 mm. in type); tibiotarsus 80.5 mm. (71.0 mm. in type); tarsometatarsus 45.3 mm. (41 mm. in type). The differential, however, is no greater than between specimens of recent Sula leucogaster brewsteri in the collections of the Los Angeles County Museum. Proportions of length of one element to another are nearly identical to those of the type of S. willetti:

tarsometatarsus to tibiotarsus, 56 per cent (57 per cent in the type); tarsometatarsus to femur, 79 per cent in both specimens; femur to tibiotarsus, 71 per cent (73 per cent in the type).

The Sherman Oaks occurrence is the fourth locality record for Puffinus diatomicus (see Wetmore, Smithsonian Misc. Coll., 131(5), 1956: 11), the third for Sula willetti, including the tentative identification of the species from the Lomita diatomite (Howard, Los Angeles County Mus. Contrib. Sci., 25, 1958: 11). Hildegarde Howard, Los Angeles County Museum, Los Angeles, California, May 18, 1962.

March 6, 1962

New records of fossil shearwaters from the Miocene of southern California.

(1) Not published?

Within the past few years, three partial skeletons of shearwaters preserved in Miocene shale have been added to the collections of the Los Angeles County Museum, and another has been sent to me for study by the Santa Barbara Museum of Natural History. Preservation of these specimens is similar to that of the several known specimens of Puffinus diatomicus Miller although more actual bone is present than in the type locality material from Lompoc, California. Since the description of P. diatomicus (Miller, 1925) five other species of shearwaters have been recorded from the Tertiary of California. Two of these are from Pliocene deposits, P. kanakoffi Howard from San Diego, and P. felthami Howard from Corona del Mar, Orange County; three are from the Miocene, P. inceptor Wetmore, P. priscus Miller, and P. mitchelli, Miller, all from Sharktooth Hill, Kern County. A fourth Miocene species was previously described from Maryland (P. conradi Marsh); and P. arvernensis Shufeldt from the Miocene of France completes the Tertiary record. Although on no one slab is the complete skeleton of P. diatomicus preserved, practically all the skeletal elements are represented in the combined specimens of this species now known. The other fossil species are represented only by isolated bone fragments; each of the four North American Miocene species is known only from the distal end of a humerus; the type of P. arvernensis is a single tarsometatarsus.

For the present study, I have been fortunate in having before me a latex mold of the type of P. diatomicus, prepared in the Museum of Paleontology, University of California, Berkeley and generously lent to me by Prof. Loye Miller. This excellent reproduction, made possible by methods and materials not available at the time the species was described, gives the specimen a three-dimensional quality difficult

to visualize in the type itself. In the type, the bones have entirely disintegrated, leaving only deep impressions of their conformation, which the latex mold has now reproduced. Studies have also been made of five specimens from the type locality and one from San Pedro assigned to P. diatomicus by Miller; with the exception of one of the Lompoc specimens belonging to the Los Angeles County Museum, this material is in the collections of the University of California at Los Angeles. A latex mold was also made of the Los Angeles County Museum specimen, ~~in the Museum's Paleontology laboratory~~.

With the several specimens plus the two latex molds now at hand, a review of the diagnostic proportions of P. diatomicus should prove valuable. Characteristics can be most readily expressed by comparison with skeletons of the present-day species, P. opisthomelas, a bird of generally similar size and conformation. From this existing species, P. diatomicus is distinguished as follows: humerus shorter than skull (see Table I for percentages); ulna also relatively short with respect to the skull, but slightly longer in relation to the humerus; tarsometatarsus actually as well as relatively longer; middle toe as long as or longer than tarsometatarsus; ectepicondylar process of humerus situated high above distal end.

Close study of the ~~new~~ three unrecorded specimens of Miocene Puffinus now at hand shows only one of the four to agree with P. diatomicus in all essentials. ~~A second~~ That one agrees with P. diatomicus in proportions but is of considerably smaller size; the other two differ in several important particulars.

Table I
Proportions of Puffinus diatomicus and P. opisthomelas compared
Ratios in percentages

	P. diatomicus	P. opisthomelas
Ratio, length of humerus to length of skull	89 - 94	100 - 109
Ratio, length of ulna to length of skull	83 - 89	91 - 101
Ratio, length of ulna to length of humerus	92 - 95	89 - 92
Ratio, length of tarsometatarsus to length of skull	62*	54 - 59
Ratio, length of tarsometatarsus to length of humerus	63 - 66	52 - 56
Ratio, length of tarsometatarsus to length of ulna	66 - 69	57 - 62
Ratio, distance from distal end of humerus to top of ectepicondylar process relative to total length of humerus	13 - 15	11 - 12

*Only one specimen of P. diatomicus has both skull and tarsometatarsus

Ratio, length of coracoid to length of humerus	32.1 - 33.7	33.3 - 35.3
Ratio, height of cranial crest to length of tibiotarsus (to articular surface)	18.8 - 20	19.0 - 21.5
Ratio, depth of humeral shaft to length of humerus	6.4 - 8.3	
Ratio, length of carpometacarpus to length of humerus	53.7 - 55.0	51.9 - 54.9
Ratio, depth of shaft of humerus relative to length of ectepicondylar process above distal end	55.6 59.9 - 61	

10.17.60

○ = largest
□ = smallest

Pufinus opisthomelas

Depth/length then	629 Type	Cotype	#3	#2	cal. Acad	UCLA (IB) good Lompoc spec.	UCLA #386 Lompoc alius spec.	L.A. Co. Mus Lompoc spec. A679 from mills	UCLA San Pedro spec.	"mex" at UCLA 11.2.61	Tepusquet Canyon SBNHM 319	(2) Ventura spec. 2706	(1) E 703 Tupanga Rd spec. Jennings	P. feltrani Phil	P. kaurahoffi Phil	P. opisthomelas Recent miller fisp.	P. ixcalibar Bakersfield	Sapelornis Nebr. Beds Nec.
Length Skull to jawline	90.0	—	—	—	—	[illegible]	79.6	—	—		—	brother 76.7?	77.3 / 78.2 depending on distortion			86		
Int coracoid Ht 29.5 cart.	27.0	27.0	22.0	—	—			—	—	28.5		—	29.4 OK (larger)			27		—
Length humerus or dist end	80.0	84.0	—	82.0	83.2	81.7	75.0	80.0	86.2	86.2	86.8	—	73.8 OK	90?	*77.5-85.1 80.5	86		—
depth sh	56?				75.2	depth 5.3	depth 5.4	depth 5.3?			5.7							
Length ulna	75.0	79.0			72.0	78.2	71.0	73.9	—		84.4	66.8	70.0 OK			78		74.5
" Coracoid	—	46.0	—	45.0	—	43.4 (44)	41.0	44.0	—		46.0 47.2	40.5 OK	38.2 40.8			45		44 +?
" femur	30.0	—	—	33.0	30.5	—	—	30.1	31.5		—	28.7	31.0 OK			31		—
" tibiotarsus	73.0	72?	—	—	72.4	68.8	69.0	70.7	70.0		—	64.0	min 68.7			65		70.3
" tarsometa	—	—		53.0	51.6	51.7	50.0	51.2	54.0		—	46.5 OK	43 max 41.5?		45-47	45		51.2
1st phal. wing	—	21	—	21.	—	20.1	19?	20.6	—		24.1		18.2			21		20.4
2nd " wing	—	21	—	—	—	(21.4) 22.8	21?	22.0	—		25.3		18.4			—		
Int coracoid. proc. olecranon	Coel 13-14				9.9	10.5?		9.7			11.0	10 ap.	9.6		9.4		4.6?	must be depth
Ht cnemial crest above articul.	11.5				11.5	12?	14.	14.3	14.7?			10.7	16.5+ 17.0					
Length jaw							71.7						69.2					
coracoid to Humerus	33.7	32.1								31.9%	36.5?		39.8 X					
Humerus (shaft) to tibia	88.9					> 75.2%	94.1 72.5%	72.3%	72.2%			fem 92.	95.6 or 94.5 96.5 or					> 72.3%
Ulna to skull	83.3						89.3					72.7-75.5	87.1 89.4	75?				
Tibia (articul.) to ulna	97.4	91?				88.2	97.0					95.6	98.3					
Tarsus to ulna				—		66.3	70.5	69 3				68.9	61.5 X					
Tarsus to hum.	—	—	—	64.6		63.2	66.5	63.6				—	58.2 X		58-55			
femur to femur	37.4			40.3								—	42.0					
femur to Ulna	40			—								42.9	44.3					
femur to ulna	93.7	94.3				95.6	94.7	92.0			97.3		94.7					
femur to ulna		54.4 58.3	— —	54.9 —		53.2-53.8 56.3	54.6 57.7	59.5			52.0 58.6	— 60.1	55.5 58.5					

Table of Measurements (in millimeters)
Miocene ~~and Pliocene~~ Shearwaters of California
Compared with Puffinus opisthomelas

	P. opistho-melas	P. diatomicus	Ventura Co.	Woodland Hills, Topanga Rd.	Published Sherman Oaks Whitehead
Length, skull	73.3 - 82.5	79.6 - 90.0	76 ap.	77	..
Length, humerus	77.4 - 85.0	75.0 - 84.0	..	73.8	..
Depth shaft, humerus	5.0 - 6.0				
Breadth shaft, humerus	2.9 - 3.3				
Breadth distal condyles, hum.	9.1 - 10.0				
Length, ulna	70.6 - 78.6	71.0 - 79.0	67.3	69.6	74.5
Length, radius	67.8 - 74.9				
Length, carpo-metacarpus	41.5 - 46.5	41.0 - 46.0	40.3	40/8	44.5
Length, femur	30.1 - 33.8	30.0 - 33.0	29.0	31.3	...
Length, tibio-tarsus to prox. artic.	60.5 - 66.3	68.8 - 73.0	63.8	68.7	70.3
Length ulna to length skull	91.3 - 101.1	83.3 - 89.3	88.5	90.5	...
tarsus, above prox. artic.	12.6 - 13.3				
Length, tarso-metatarsus	42.9 - 47.4	50.0 - 54.0	47.2	41.5 ?	51.2
Length, coracoid (internal tip)	26.3 - 29.2	22.0 - 27.0	...	29.4	...
Ratios (in %)					
Length humerus to length skull	100 - 109	88.9 - 94.1	....	96.0	...
Length ulna to length humerus	89.8 - 92.6	92.0 - 95.6	...	94.5	...
Length tarsometatarsus to length humerus	53.2 - 57.5	63.2 - 66.5	...	51.2	....
Tarsometatarsus to Length cnemial crest to length of tibiotarsus		66.3 - 70.5	70.3	59.5	68.6
Length tibiotarsus to length ulna	83.6 - 86.7	88.2 - 97.4	94.9	98.6	94.3

P. diatomicus compared to 554 opisthomelas →

Humerus shorter than skull	Hum. longer than Skull	Tyranya spec. Vent.
		Litho diat.
Tibia longer than coracoid	Tib. shorter than diat.	Tibia longer than opistho
Coracoid shorter than opistho	Coracoid longer than diat	coracoid = opistho longer than diat
Ht of cranial crest 23.7% of length tib	23% length Tibia	23-24% length tib.
Capus to hum 54+0-%	52-54%	5.43
Ht ectepicond. process from dist. end. 12.8%	11-12%	13%
Ratio length rostrum to length skull 57%	54%	54%
Length femur & length tibia 72.4-75.3	70.5, 72.0	
Actual length Tibia 68.8-73	60.5-66.2	
Actual length humerus 75-84	77.4-85	73 or 74
Ratio tib. to humerus 84-92%	78.3-79	ap. 73%
Ulna to humerus 92.4, 94.3, 95.7, 94.7	89.4-92.4	
Depth humerus x length 7.4.		

3.8 : 52 = X : 80
52X = 304
X = 5.6

Check the following chars in new fossil Puffinus

rel. ht of tibia cnemial crest (23% of ht to art. surface in P. diatomaceus)

ht of coracoid (♂ lumenus?) 32–33.5% in P. diat.

length of femur rel to length humerus 63–66%

Depth shaft ↑ ht ectepicond process

	Topanga		Ventura diatomites				Ventura
skull	77.3-78.5	14%	16-3	79.6-90	[2]	12%	77.0
humerus	73.8	16%	" " "				
ulna	70.0	13%	17-5	75.0-84.0 (or 86.2)	[7]	14%	—
carpus	40.8		13-1	71.0-79	[6]	11%	67.3
femur	31.2		13-3	41.0-46	[5]	12%	40.5
tibia	68.7-69.0		14-7	30.-33	[4]	10%	29.0
tarsus	41.5-43.0	25%	14-6	68.8-73.0	[6]	6%	64.0
coracoid	29.4		—	50-54.0	[5]	8%	47.0?
coracoid	39.7%		—	22.-27 (28.5?)			—
			—	33.7, 32.2, 33.1	[3]		—

	Type* or mus. spec		Ventura	Vent/Type	co-type max		
skull	90	—	76.7+	-16.8%	—	90	16.8
humerus	80	80	—	—	84	86.2	—
ulna	75	74	67.5	-11	79	79	17%
carpus	—	44	40.3	-9	46	46	14
Coracoid	27		—	—			
Femur	30	34	28.7	4-8		33	15
tibia	73	71	64.0	14	72?	73	14
tarsus	—	51	46.5	10		54	14

Tefurpect Canyon shearwater (Sta Barbara mus. specimen)
ulna larger than P. diatomista by 6%
carpo. " " " " " 6%

Since the description of Puffinus diatomicus Miller (1925) from the Miocene diatomaceous shales at Lompoc, California, five other species of shearwaters have been described from the Tertiary of California; two from the Pliocene (P. kanakoffi Howard and P. felthami Howard) and three from the Miocene (P. inceptor Wetmore, P. priscus Miller and P. mitchelli Miller). A fourth Miocene was previously described from the Miocene of Maryland (P. conradi Marsh)

~~Within the past few years, three partial skelet~~

P. diatomicus is known, from imp

Practically the entire skeleton of P. diatomicus is known, from impressions and partial preservation of bone in at least twelve slabs of Miocene shale On no one slab, however, is the complete skeleton preserved.
By
Practically the enitre skeleton of Pl diatomicus is known from at ~~least~~ twelve slabs

At lea

The other fossil species are represented only by isolated bone fragments. ~~In fact each of the four Miocene species is known only from the distal end~~ of a humerus. from the each

Within the past few years, three partial skeletons of shearwaters, preserved in Miocene shale, have been added to the Museum's collections and another has been sent to me for study by the Santa Brabara Museum of Natural History. Preservation of these xxxxxxxxx fossils is similar to that of the several known specimens of P. diatomicus. ~~A close study of~~ them indicates that only one can be assigned to this well known species; another is tentatively so assigned.

~~Inxxixewxofxthexpxssibilixychatxxx~~
The other two might possibly belong either to Pl priscus or to P. mitchelli, but as detailed study of the ~~contours~~ of the distal end of the humerus is impossible, definite assignment of these specimens, must await further discoveries in the Sharktooth Hill area

See data other side

	dwat,	opisthocoelous S.B #319	P. prisca	P. mitchelli
Humerus	75.0 – 84.0 (86.2)	87.2		
Ulna	71.0 – 79.0	85.7		
Carpometa	41.0 – 46.0	46.0		
Coracoid	22.0 – 27.0 (28.5)	31.8 (?)		
a Depth shaft humerus	5.3 – 5.9	6.8	6.3 – 6.4	7.0 6.7
b Ht ectepi	8.6 – 9.7	10.0	10.2	10.5
c length base	—— ?	4.6 4.2	3.7 3.2	3.3 5.1
b/c		46.0	36.2	30.4
a/b		68.0	62.6	66.6 63.8

Ratios

~~Ulna~~/humerus	92 – 95.6	89.8 – 92.6	98.5
carpus/humerus	53.1 – 54.8	51.9 – 54.9	52.7
carpus/ulna	55.5 – 58.3	57.1 – 60.1	53.6

~~Measurements~~ In specimens of this size deviations of a mm. can ~~be interpreted~~ easily be made in the manner in which a meas. is taken. Loye Miller, ~~in correspondence~~ (correspondence 11.1.61) has kindly provided me with measurements of the ectepi condylar process of P. prisca & P. mitchelli. He also indicated that the meas the depth of the groove distal of the shaft can vary ~~as much as~~ slightly depending upon the position of the calipers. Thus the measuring P. mitchelli could vary from 7.0 (as published) to 6.7 mm.

$$872\overline{)46.00}\ 05'27 \qquad 872)4360\ 2800\ 1744\ 4560\ 6104$$

$$817\overline{)43.40}\ 53.1 \qquad 4085\ 2550\ 2451\ 990$$

$$82\overline{)4500}\ 54.8 \qquad 410\ 400\ 328\ 5720$$

$$782\overline{)4340}\ 55.5' \qquad 3910\ 4300\ 3910\ 3900\ 98.2$$

$$872\overline{)8570}\ 7848\ 7220\ 6976\ 2440$$

Summary + Conclusions

~~Four new additional specimens of Puffinus from~~

Specimens of Puffinus ~~have recently been received from~~ 4 ~~additional~~ new Miocene localities are analyzed ~~and compared~~ in comparison with the other recorded Mio. sp. of the genus.

Muir #556
max #541 or 559
mouth breadth vary among others as well

Shaw Creek measurements

Pupuius opis Thomelas

	5'55'	5'56	541	5'54	5'58	1373	5'57	553	542	543	559	51	3.00		P. temi notes	P. p. corrected
	← Laguna →					mesa	← Laguna →					Del Rey	San Diego			
A1 Length humb	84.7	77.4	85.0	84.5	82.5	83.5	81.5	84.7	64.4	80.5	85.0	82.4			100.4	100.4
B Distal br. cond.	8.2	7.4	9.8	7.8	7.7	7.6	7.3	7.8	7.6	7.4	7.5	7.5			9.2	8.7
B3 Depth sh	5.6	5.2	5.0	5.7	5.3	5.3	5.2	5.4	5.6	5.4	6.0	5.3			6.3	5.1
B4 Br sh	3.1	3.1	2.9	3.3	3.0	3.1	3.1	3.0	3.2	3.2	3.2	3.1			3.6	3.7
B5 Length fac from radiale	9.8	9.1	9.8	9.7	9.5	9.6	9.8	9.4	9.9	9.5	10.0	9.7			10.8	9.8
B6 Length coracoid	29.2	26.3	29.0	28.5	28.4	27.8	28.5	28.3	29.2	28.4	28.5	28.9				26.0-3
C1 Length fem Ext	32.4	30.0	33.8	32.6	31.2	32.1	31.8	32.9	32.2	31.4	32.6	32.8				33.9
C2 " " INT	31.4	28.5	31.8	31.6	30.2	30.9	30.7	31.6	30.8	29.5	31.1	31.3				32.4
D Total Length Ulna	78.4	70.6	76.3	76.7	74.2	77.4	73.5	75.7	77.5	73.1	78.6	74.9				105.2
E1 F.O artic Length Tibia	65.5	60.5	66.2	65.2	62.1	66.3	63.5	65.0	65.2	62.5	65.7	66.0				69.5
E2 total Length Tib	78.7	73.8	79.7	78.1	74.7	79.2	75.9	78.2	77.8	75.3	79.5	79.4				80.1
F Length radius	—	67.8	73.2	73.9	71.3	74.4	71.1	73.0	74.7	70.0	74.9	72.8				102.0
G1 Ext Length compo-	44.7	41.5	46.5	44.3	42.7	45.2	44.2	46.5	46.3	42.8	45.0	44.6				50.9
G2 " " INT	44.2	41.3	45.7	44.0	42.3	44.6	43.6	45.6	45.5	42.4	44.5	44.0				49.9
H1 Cenbm Length Tarso-	45.9	42.9	46.1	46.1	44.0	46.8	45.6	46.0	46.5	44.7	45.6	47.4				42.4
H2 " " I.M	43.1	40.8	44.3	43.5	41.4	44.4	43.2	43.7	44.4	42.5	43.1	44.8				44.4
H3 EXT " "	44.9	41.6	43.3	44.9	43.5	45.7	44.2	44.6	45.3	43.0	44.0	46.6				45.4
J1 Total Length Skull	81.5	73.3	82.0	78.0 remeas	76.9	76.2	80.9	79.6	79.6	82.3	82.5	81.8	8.11	#63	78.4	85.0 82.4
Bn/depth sh humerus	55	54	58	58	56	58	54	55	57	59	53	58			57%	72%
depth sh/length humerus	64	67	59				63				70	84				
femur / humerus	52.6%	53.9	52.3	53.1	52.0	54.5	54.7	52.8	53.8	53.9	51.9	56				
" / skull	54.7	56.9	54.2	57.5	55.7	59.7	55.3	56.2	55.0	54.5	53.5	54.4				

reverse

carpus & ulna
humerus to skull
coracoid & tarsus
tarsus & ulna
" & tibia

tibia & ulna
tarsus & humerus

P. agilis Anamelas

Ratios	55'5'	55'6	541	554	558	557	553	542	543	559	5'1	1373	min	max	Degree of dif.
Humerus & skull ✓	104%	105%	104	108	107	101	106	104	97.7	103	100.5	109	97.7	110	2.3%
(Articulation) Tibia & ulna ^	84.7	85.6	86.7	85	83.7	86.5	85.7	84.2	85.4	83.6	88.3	86.0	83.6	86.7	3.1%
Tarsus & humerus	54.2	55.5	54.3	54.6	53.2	55.8	54.3	55.1	55.5	53.6	57.5	56.1	53.2	57.5	4.3%
Femur & humerus	38.3	39.0	39.8												
Humerus & ulna	92.4%	91.4%	89.8%	90.7	89.9	90.3	89.4	91.7	91.0	92.4	90.9	92.6	89.8	92.4	3.2
ulna & skull	95.3%	96.6	93	98.5	96.5	91.0	95.0	~~97.4~~ 94.0?	~~88.6~~ 92.0?	95.5	91.3	109.1			
tarsus & skull	55.9%	57	53.8	57.6	57.	54.5	56.5	54.5 mean	54.5 mean	54.0	56.0	59.0			
carpus & humerus	54.7	53.7	54.7	52.4	51.9	54.2	54.9	54.7	53.2	53.0	54.2	54.1	51.9	54.9	3.0
tarsus & tibia	70.1	71.0	69.6	70.7	70.7	71.9	70.7	70.3	71.6	69.5	71.7	70.7	69.5	71.7	2.2
carpus & ulna	57.1	58.0	60.9	57.7	57.5	58.4	60.1	58.4	58.6	57.3	59.6	58.3	57.1	60.1	3.0
Tarsus & ulna	~~58.5~~ 59.1	60.6	60.5	60.2	59.4	63.0	~~59.0~~ 60.7	60.0	61.3	57.9	~~61.7~~ 63.3	~~59.0~~ 60.5	58.5	63.3	7.8
coracoid & humerus	34.5	34.0	34.1	33.7	34.4	34.9	33.4	34.7	35.3	~~33.5~~ 34.5	35.1	33.3	33.3	35.3	2.0
Hyoscleri to hypothenum, left scleri to left skull	11.5	11.7	11.5	11.4	11.5	12.0	11.1				11.7	11.5			
	57.3	57.3	51	58.7	55.6	53.3	57.5	55.6	57	60	54.7	55.3			

Sup. comparisons with diabetics

coracoid to hum diat.	32.1 - 33.7	33.3 - 35.3
tibia to ulna "	88.2 - 97.4	83.6 - 86.7
Tarsus to ulna diat.	66.3 - 70.5	— opposite → 58.5 - 63.3
" " hum "	63.2 - 66.5	53.2 - 57.5
" " tib "	72.3 - 77.2	69.5 - 71.7
ulna " skull	83.3 - 89.3	92.0 - 101.1
hum " skull	88.9 - 94.1	98.0 - 109.

Measurements of Shearwaters and Fulmars
(Made by Dolores Lyttle - July, 1944)

	Humerus	Ulna	Carpometacarpus	Femur	Tibiotarsus	Tarsometatarsus	Ratio Tarso to Humerus
P. gurneyi Bi 50	104.5	96.5	53.0	38.0	82.4	54.9	
" " Bi 64	106.0	99.9	—	38.7	84.4	—	
Bi 577	108.5	102.0	56.3	39.0	86.8	58.3	
P. Pisthomelas Bi 554	84.7	77.0	44.5	33.5	65.4	46.0	
" " Bi 542	84.4	77.4	46.4	32.7	65.3	46.5	
" " Bi 1378	83.	77.0	45.2	32.0	66.1	46.4	
" " Bi 51	82.4	75.0	44.8	33.3	66.1	47.1	
" " Bi 541	85.1	76.5	46.0	33.7	66.3	46.0	
" " Bi 543	80.5	73.0	43.0	31.5	62.6	43.8	
" Bi 544	81.8	73.5	43.8	32.6	64.5	45.4	
" Bi 553	84.6	76.0	46.5	33.5	65.6	45.1	
" Bi 555	84.8	—	44.6	32.9	65.5	45.1	
" Bi 557	81.7	73.3	44.0	32.4	63.5	45.5	
" Bi 558	82.4	74.3	45.2	31.4	62.7	44.0	
" Bi 559	85.0	78.5	45.2	32.5	65.6	45.5	
" Bi 556	72.5	70.6	41.8	30.0	70.5	42.5	
P. Creatopus Bi 362	—	108.2	56.7	41.9	80.3	52.7	
" Bi 698	114.0	111.8	56.8	42.3	80.1	54.2	
" Bi 349	114.0	—	—	42.3	—	—	
348	114.7	112.3	—	41.4	—	—	

	Humerus	Ulna	Carpometacarpus	Femur	Tibiotarsus	Tarsometatarsus
P. Obscurus Subalaris Bi 1358	62.3	60.7	—	24.7	50.4	—
P. pacificus Cuneatus Bi 1375	101.3	105.0	52.0	34.0	69.8	48.1
" " Bi 1375	101.5	104.4	51.0	33.8	70.0	47.5
Rodgersi Bi 464	—	97.0	49.3	—	78.2	47.1
Fulmarus Glacialis " " Bi 672	102.0	99.1	49.0	42.0	79.6	47.4
" " Bi 618	99.0	94.3	45.6	41.4	78.0	42.5
" " Bi 619	102.5	98.6	48.4	43.5	79.9	49.3
" " Bi 620	106.5	101.5	49.9	43.0	82.4	50.4
" " Bi 59	110.3	106.1	50.4	47.0	85.5	49.7
" " Bi 36	102.3	91.0	47.5	42.0	81.5	48.7
" " Bi 27	103.3	99.0	48.8	43.0	81.7	48.5

Typeg dinosaurs (Cont'd)

meas of LACM 2703

90 Lgth jaw — 68.2

80 Humerus — 74.3 ? 69.9

75 Radius — 66.2 ulna 70

45 Carpometa — 44.0

27 Ht Coracoid — 29.4

53 Tarsometa — 43.2 ? 41.5 est'd

72 Tibia — 68.3 ? 72.5 ? incomplete, est'd

Femur 30?

Taffinus LACM 2703

from Mike Jennings

23251 Lemora St

Woodland Hills

Near Ventura Blvd. on

Old Topanga Road turnoff

humerus differs from kamakhpi in deeper bicipital impression
+ further kakapi. process 9.4–9.5 vs 8.9 of 9.0 in kamakhpi 1, 23, 67 good

& Toro Pafferus

	Tyke calhoni R 17508	Reb calhoni L 17539	[illegible] R (dark) (with ulna)	water worn R 17540	Dark Shaft L	P. opith 1373	+ 541	555	542	− 558	543	+ 553	+ 554	+ 557	+ 559	− 558	51	Mic grisea 50	Jefthaeus	Kgp kelp
Humerus																				
Br. dist. end humerus	7.1	7.1	7.5	—	—	7.15	7.68	7.5	7.5	7.0	7.4	7.2	7.6	7.2	7.5	7.3	7.2	8.9	8.6	7.3
Br / depth sh	3.0/6.2	3.3/5.9	—	3.3/5.8	3.2/6.2	3.4/5.8	3.4/5.8	3.1/6.1	3.4/6.1	3.1/5.3	3.3/6.1	3.2/5.85	3.4/6.1	3.2/5.7	3.3/6.4	3.2/5.4	3.2/5.7	4.5/7.5	3.8/7.2	3.0/3.8
Br ext cond.	3.0	3.2	3.7	—		3.3	3.0	3.5	3.3	3.3	3.4	3.2	3.3	3.1	3.4	3.1	3.3	4.0	4.1	3.3
Tarsus																				
Br. prox end	6.6/5.7	7.0	7.2	3/4 L		6.2	6.6	6.4	6.1	6.35	6.35	6.5	6.2	6.9	6.7	5.9	6.4	8.0	7.3	6.4
Br. sh. 10 mm down	3.0	3.5	3.0	3.1	4.1	3.1	2.6	2.9	2.9	2.9	2.7	2.8	3.2	2.85	2.8	2.7	2.7	3.4	3.6	3.3
Depth ext. sh. dia. 19 mm	4.4	4.5	4.2	—	5.9	3.3	5.4	3.8	3.8	3.5	3.7	3.4	3.9	3.5	3.8	3.3	3.4	4.4	4.2	3.9
Tibia																				
Br. prox.	6.3	6.6	6.6	6.9		6.6	6.9	—	6.9	6.75	7.0	6.6	6.9	6.6	6.9	6.7	6.9	8.3		
Dep. th. prox	7.7	7.7	7.8	7.9		7.75	8.2	—	8.2	7.8	8.0	8.2	8.4	7.9	8.4	8.2	8.0	9.6		
Br. sh. at attach my addition	—	3.8/4.3	—	—	3.8/4.8	3.6/4.1	3.7/4.3	—	3.8/4.05	3.7/4.3	3.7/4.5	3.5/4.1	3.9/4.5	3.6/4.3	3.8/4.2	3.5/4.3	3.6/4.4	5.1/5.6		
Br. below articular	6.5	6.1	5.7	—	5.6	6.7	6.8	—	6.9	6.4	6.7	6.4	6.2	6.4	6.5	5.9	—	7.7		
Dist. Br. condyles	4.7	4.3	4.2	4.3	4.5	4.2	4.1	4.1	4.1	3.9	4.1	4.1	4.3	4.2	4.2	4.1	4.1	4.9	3.9	
Br. shaft	4.8	4.7	—	4.8	—	4.4	4.6			4.15			4.5						4.2	
Depth ext. dist.	5.75	5.6	5.15	5.7	6.05	5.9	6.1	5.94	5.75	5.7	5.8	5.5	5.6	5.7	6.0	5.7	5.6	7.4	5.1	
gr. diagonal dist. breadth	7.8	7.5	7.2	7.9	8.1	7.3	7.4	7.2	7.3	7.1	7.1	7.1	7.3	7.2	7.4	7.2	7.2	9.0	6.8	
Coracoid																				
Br. below head from dorsal	5.5	5.4	5.4	5.7		4.9	5.2	5.0	4.9	4.7	4.7	4.6	5.0	4.9	5.1	4.6	tendon	5.8		
Procoracoid	12.4	11.7	—	—		11.5	12.3	11.8	11.4	10.8	11.0	11.1	11.7	11.8	11.6	11.4		14.0		
Br. furcal plate ant	5.3	5.75	5.25	5.4		5.1	5.0	4.9	5.3	4.3	4.8	4.2	5.0	5.1	5.5	4.6		6.0		
Br. dist. th. clavicle scapula	4.6/6.0 R	4.4/5.25 R	4.7/6.3 Lt. L	4.55/6.35		4.7/6.2	4.2/6.3	—	—	3.8	—	4.2	4.3/6.4	—	—			—		
br. prox	9.7	10.1	9.2			8.6	10.2	—	—	5.5	—	5.7	9.5	—	—			11.5		